

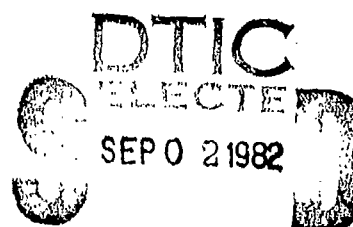
AD A118803

Special Report 82-1

6

MULTIPLEX CONTROLLER APTITUDE TEST
AND OCCUPATIONAL KNOWLEDGE TEST:
SELECTION TOOLS FOR AIR
TRAFFIC CONTROLLERS

M. G. Lilienthal and F. S. Pettyjohn



E

December 1981

DTIC FILE COPY

NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY
PENSACOLA FLORIDA

This document has been approved
for public release and sale; its
distribution is unlimited.

82 09 02 014

Approved for public release; distribution unlimited.

**MULTIPLEX CONTROLLER APTITUDE TEST AND OCCUPATIONAL
KNOWLEDGE TEST: SELECTION TOOLS FOR
AIR TRAFFIC CONTROLLERS**

M. G. Lilienthal and F. S. Pettyjohn

Interagency Agreement No. DTFA01-80-Y-30528

Reviewed by:

**Ashton Graybiel, M.D.
Chief Scientific Advisor**

Approved and Released by:

**Captain W. M. Houk, MC, USN
Commanding Officer**

December 1981

**Naval Aerospace Medical Research Laboratory
Naval Air Station
Pensacola, Florida 32508**

ABSTRACT

The cost of training Air Traffic Control (ATC) personnel has risen rapidly. Attrition of students prior to completion of the training results in loss of invested funds as well as a delay in providing a fully qualified ATC specialist to the field for both military and civilian agencies. Improved selection and prediction tests for ATC personnel have been recognized as essential to decrease attrition rates. This study examined the selection utility of the Federal Aviation Administration (FAA) prototype ATC test battery. The test protocol consisted of the Multiplex Controller Aptitude Test (MCAT), a job simulation test; and the Occupational Knowledge Test (OKT), a job knowledge specific test. Two-thousand four-hundred ninety-nine FAA/ATC Academy trainees from the 1978 through 1980 period had taken two versions of the Multiplex Controller Aptitude Test (MCAT1 and MCAT2) and one version of the Occupational Knowledge Test (OKT). Test scores for 1,954 of these subjects were merged with information concerning their sex, education, ATC experience, ATC option, and pass/fail status at the ATC Academy.)

Regression analysis indicated that the predictive validity for successful completion of the FAA ATC curriculum of the MCAT1, MCAT2, and OKT, was significant at the $p < .001$; however, the R^2 was low ($R^2 = 0.12$). Consideration of causes for the low R^2 includes nonuniform distribution of subjects and possible preselection as the population sampled had previously passed FAA/ATC entry criteria.

Item analyses indicated the MCAT contained very difficult or very easy items in over 50 percent of the test questions. The OKT had acceptable levels of item difficulty at the 25 percent level. ^

Analyses of variance of the versions of each selection test (MCAT1, MCAT2 and OKT) indicated significant differences among the versions. The nonuniform-distribution of subjects and a learning effect between the test versions were considered as contributing to these differences. Subject sampling and design counterbalancing problems were discussed as possible contributing factors to the low overall R^2 .

Recommendations are presented for further revision and analysis to improve question utility and to develop a sequential test evaluation of the ATC applicant's learning abilities.



Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A	

ACKNOWLEDGMENTS

The authors are indebted to Mr. Delbert N. Turner and Mrs. Dorothy M. Davis, for the typing support in the preparation of this report.

TABLE OF CONTENTS

	<u>Page</u>
ABSTRACT	ii
ACKNOWLEDGMENTS	iii
INTRODUCTION	1
METHOD	2
RESULTS	2
DISCUSSION	36
SUMMARY	42
RECOMMENDATIONS	42
REFERENCES	43
APPENDICES	44

INTRODUCTION

Effective selection of Air Traffic Control personnel has been a continuing problem for both military and civilian agencies. In the 1980s, with the rising cost of training and with the sudden great shortage of civilian Air Traffic Controllers (ATC), the federal government cannot afford to select an individual who does not have the necessary cognitive capabilities to complete ATC School. The current Federal Aviation Administration (FAA) Office of Personnel Management selection battery for ATC personnel has been operational since 1964 (1). The FAA has experienced a range of attrition rates from as low as 20 percent to as high as 40 percent of ATC personnel during the two-to-four year training period required to reach the Full Performance Level (FPL) controller (2). A projected attrition rate of 20 percent from the time of entry on duty until reaching FPL of an estimated 1800 new controllers (average personnel annual intake) would result in an FAA loss of 14 million dollars invested in salaries, training, and equipment (3).

The Biomedical and Behavioral Sciences Division, Office of Aviation Medicine, Federal Aviation Administration, is currently involved in a developmental program to formulate and to implement job relevant selection instruments for ATC personnel. At present, all applicants who wish to become ATC personnel must pass both the Civil Service Commission (CSC) ATC Aptitude Test and a physical examination in order to be eligible for employment. Improvement in selection testing is needed for early identification of trainees that do not possess the aptitude and the ability to progress to FPL. A major reduction in FAA's investment loss from developmental controller attrition could be realized through an improved test battery (4).

The U.S. Military Services conduct ATC training with similar attrition problems. Persons desiring to be U.S. Navy ATC personnel must pass portions of the Armed Services Vocational Aptitude Battery (ASVAB). A composite score of the ASVAB's Arithmetic, Mathematics Knowledge, and the General Sciences subtests is currently used as the criteria for acceptance into the Navy ATC program. These tests are the result of almost 40 years of selection research and development; however, there is still a 30 percent attrition rate at the Navy ATC School. Of the students that complete the Navy training program, approximately 40 percent require additional classroom instruction to successfully complete the tower laboratory phase of the curriculum (5). This unacceptable attrition rate, along with increased air traffic workload and new technological advances, emphasizes the need for improved selection tests.

FAA efforts over the past six years have resulted in the development of the Multiplex Controller Aptitude Test (MCAT) and the Air Traffic Controller Occupational Knowledge Test (OKT) as ATC selection tools. The MCAT is a customized test that emphasizes job simulation and relevance. It is a timed paper-and-pencil test in which 40 percent of the items attempt to measure the student's ability to predict violations of air traffic separation standards, conflicts and mid-air collisions. The student's ability is tested by a simulated radarscope and flight information table (Figure 1). The remaining 60 percent of the items assess aptitude skills in table reading, spatial visualization, and arithmetic reasoning (6).

The OKT was developed by the Office of Aviation Medicine/FAA with the help of several journeymen controllers. These journeymen are at FPL with the FAA currently performing the full range of ATC operational duties. The OKT is a job-knowledge specific test that measures the applicant's knowledge of ATC work retained from prior experience. The OKT samples knowledge concerning Air Traffic Control regulations, terminal and enroute air traffic control, communications, flight service station work, navigation aids, weather, and radar (7).

In an agreement with the FAA, the Naval Aerospace Medical Research Laboratory (NAMRL) conducted research analysis of the MCAT and OKT test batteries to determine their predictive ability in the civilian community and to recommend selection research procedures for Navy ATC candidate populations.

METHOD

SUBJECTS

Subjects were drawn from ATC candidates from the 1978 through 1980 FAA Academy population who were administered the MCAT and the OKT. All subjects had volunteered their test scores to be used for ATC personnel selection studies. Only those subjects who had taken two versions of the MCAT and at least one version of the OKT were utilized in this study. The reason for exclusion of 614 subjects are listed in Table 1. A total of 2,499 subject MCAT and OKT answer sheets were analyzed. There were a total of 1609 males (82.3%) and 345 females (17.7%). Caucasians comprised 89.4 percent (N = 1747) of the total sample, and Blacks comprised 7 percent (N = 136) of the subjects. Thirty-eight (27.9%) of the Black applicants, 300 (17.2%) of the Caucasian applicants, and seven (9.8%) of the "other" minorities were female (Table 2).

PROCEDURES

Each subject was presented with two of the ten test versions of the MCAT. Each MCAT test contained 55 multiple choice items. The tests were each divided into two sections with approximately equal questions. In the first section, subjects were given eight minutes to study the directions and to memorize the characteristics of the aircraft presented on the simulated air traffic radar screen (Figure 1). They were allowed 20 minutes to answer the questions. Before the start of the second section, subjects were given one minute to study the next radar scenario followed by fifteen minutes allowed for completion of the section. Table 3 provides the various orders of presentation of the two MCAT versions to the subjects.

The ATC candidates were also administered at least one of the ten versions of the OKT. All OKT tests had 100 multiple choice items with the exception of OKT 101C, which had 59 scored questions. The test had a 45 minute time limit.

RESULTS

Tests and Questionnaire: Subjects' first MCAT (MCAT1), second MCAT (MCAT2) and OKT test sheets were optically scanned and computer scored. A total of 1,954

Table 1

Subjects Excluded from Study

REASON	<u>N</u>
ONLY ONE TEST TAKEN	32
ONLY ONE MCAT TAKEN	87
NO OKT TAKEN	391
MCAT VERSION UNKNOWN	6
OKT VERSION UNKNOWN	74
NO NAME OR IDENTIFICATION NUMBER	18
INVALID	<u>6</u>
TOTAL DROPPED	614

Table 2

Gender - By Race

FREQUENCY			
ROW PERCENT			
COLUMN PERCENT	MALE	FEMALE	TOTAL
CAUCASIAN	1447	300	1747
	82.8%	17.2%	89.4%
	89.9%	86.9%	
BLACK	98	38	136
	72.1%	27.9%	7.0%
	6.0%	11.0%	
OTHER	64	7	71
	91.1%	9.9%	3.8%
	3.9%	2.0%	
TOTAL	1809	345	1954
	82.3%	17.7%	100.0%
MISSING DATA = 545			

Table 3

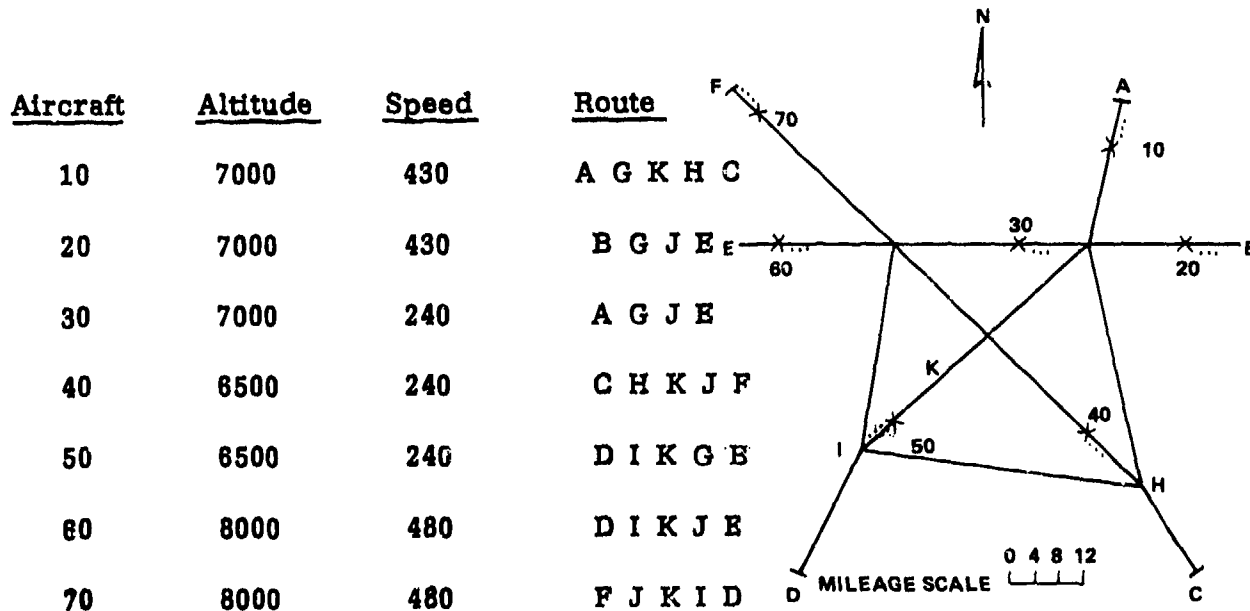
Order of MCAT Presentations

MCAT1	MCAT2
4e8o	4o8e 7e4o (D)
4o8e	7o4e 4e6o
6e7o	6o7e
6o7e	6o7e 6e7o
6o7e (B)	7e4o 4o8e
6o7e (C)	6o7e (C) 6o7e (D) 7o4e
6o7e (D)	7o4e
7e4o	6e7o 7o4e
7o4e (D)	4e8o
7o4e	6o7e (D) 7e4o

FIGURE 1

DIRECTIONS

THE MULTIPLEX CONTROLLER APTITUDE TEST



QUESTION WILL APPEAR HERE

In this test you will observe pictures of a simulated radar scope with aircraft moving across it. Your task will be to observe these aircraft, evaluate their flight information as given in a table to the left of the scope, read questions which appear below the table, and record your answers to the questions on a separate answer sheet.

subjects' MCAT and OKT test scores were merged with background questionnaire responses and ATC school data extracted from the Civil Aeromedical Institute's data base. There are four ATC options, which include Air Route, Traffic Central Center (Enroute), IFR (Instrument Flight Rules), VFR (Visual Flight Rules), and FSS (Flight Service Station). The FAA treats IFR and VFR as one Option, identified as Terminal. The hierarchy of lowest to highest complexity of Options is FSS, VFR, IFR, and Enroute.

Background questionnaires and ATC School data were available for only the Enroute and Terminal Options. The proportion of subjects in each Option was approximately equal; 49.4 percent of the subjects were in the Enroute phase and 50.6 percent in the Terminal phase. Fifty percent of the males were in each phase, while 46.6 percent of the females were in Enroute training as opposed to 53.4 percent in the terminal Option (Table 4). There was no statistically significant sex preference between the Enroute and Terminal Options ($\chi^2 (1) = 1.34, p > .05$).

All subjects who had provided education information met the minimum requirement of a high school education with 85.7 percent having at least some college training (Table 5). The distribution of females among the three education levels was not significantly different from that of the males ($\chi^2 (2) = 5.58, p > 0.05$). However, the males had significantly greater previous ATC or related experience than females ($\chi^2 (2) = 118.2, p < 0.01$). Table 6 indicates that 53.9 percent of the males had previous ATC experience, but only 24.1 percent of the females had any ATC background.

Test Scores: The mean, standard deviation, minimum, maximum, skewness, and kurtosis were computed for each version of the MCAT for both the first (Table 7) and the second (Table 8) presentations of the test. All of the MCAT1 tests had a negative skew (ranging from -0.17 to -0.02) indicating, in conjunction with the means of the tests, that the subjects tended to score toward the high end of the test scale. The same held true for the MCAT2 where all but one test version (MCAT 6o7e(B)) had greater negatively skewed distributions than their MCAT1 counterpart versions. The kurtosis was more leptokurtic for the MCAT2 as opposed to the MCAT1 again, except for 6o7e(B), which became slightly more platykurtic. Thus, there appeared to be a learning effect transferred from MCAT1 to MCAT2 resulting in higher mean scores on the later test.

OKT mean, standard deviation, minimum, maximum, skewness, and kurtosis were also calculated (Table 9). There were negative skew for most of the OKT tests with the exception of OKT 102B and OKT 102D. This skew ranged from -0.68 to 0.19. Kurtosis was negative (platykurtic) except for positive 0.27 for OKT 102E. There was a more uniform distribution of scores for the OKT than for the MCAT tests.

The test scores were analyzed at the request of the FAA by Option, Education, Race, and Sex. Table 10 presents the mean score and standard deviation for each of the three FAA tests by Option. Those subjects in the Enroute Option received an average MCAT1 score of 38.15, which was found to be significantly higher than the mean score of 37.02 for those in the Terminal Option ($t (1986) = 3.43, p < .001$).

Table 4

Option

FREQUENCY ROW PERCENT COLUMN PERCENT	Option		TOTAL
	MALE	FEMALE	
ENROUTE	819 83.4% 50.0%	162 16.5% 46.5%	981 49.4%
TERMINAL	820 81.5% 50.0%	186 18.5% 53.4%	1006 50.6%
TOTAL	1639 82.5%	348 17.5%	1987 100.0%
MISSING DATA - 512			

Table 5

Education

FREQUENCY ROW PERCENT COLUMN PERCENT	MALE	FEMALE	TOTAL
HIGH SCHOOL	204 81.3% 14.1%	47 18.7% 15.1%	251 100% 14.3%
SOME COLLEGE	705 84.5% 48.7%	129 15.5% 41.5%	834 100% 47.4%
COLLEGE	538 79.9% 37.2%	135 20.1% 43.4%	673 100% 38.3%
TOTAL	1447 82.3% 100%	311 17.7% 100%	1758 100%

MISSING DATA = 741

Table 6

Air Traffic Control Previous Experience

FREQUENCY			
ROW PERCENT			
COLUMN PERCENT	MALE	FEMALE	TOTAL
NONE	403	179	582
	69.2%	30.8%	100.0%
	28.0%	59.1%	33.4%
NON-ATC	281	51	312
	63.7%	16.4%	100.0%
	18.1%	19.8%	17.9%
ATC	775	73	848
	91.4%	8.6%	100.0%
	53.9%	24.1%	48.7%
TOTAL	1439	303	1742
	82.6%	17.4%	100.0%
	100.0%	100.0%	
MISSING DATA = 757			

Table 7

Descriptive Statistics:
 Multiplex Controller Aptitude Test - Part 1
 NCAT

TEST VERSION	N	MEAN	S.D.	MIN	MAX	SKEWNESS	KURTOSIS
4o8e	354	34.38	6.70	12	50	-0.26	-0.16
4e6o	498	35.50	8.32	6	51	-0.28	0.98
6o7e	216	39.33	6.92	20	53	-0.54	-0.14
6e7o	498	36.64	6.32	15	52	-0.17	-0.09
6o7e(B)	145	39.47	7.11	19	53	-0.56	-0.21
6o7e(C)	73	40.67	6.10	26	51	-0.43	-0.66
6o7e(D)	57	31.65	7.65	11	45	-0.40	-0.37
7o4e	124	33.97	7.91	10	51	-0.47	0.33
7e4o	481	39.62	7.15	11	52	-0.02	1.15
7e4o(D)	48	36.57	9.19	11	51	-0.89	0.45

Table 8

Descriptive Statistics:
 Multiplex Controller Aptitude Test - Part 2
 MCAT2

TEST VERSION	N	MEAN	S.D.	MIN	MAX	SKEWNESS	KURTOSIS
4o8e	392	40.28	5.62	17	52	-0.69	0.86
4e6o	115	41.64	6.43	8	51	-1.70	5.57
6o7e	785	44.83	5.51	13	54	-1.41	3.48
8e7o	183	40.34	6.15	11	54	-0.77	1.94
6o7e (B)	42	44.90	3.94	35	51	-0.55	-0.19
6o7e (C)	117	45.74	5.40	19	54	-2.10	6.77
6o7e (D)	60	36.32	5.72	20	45	-1.34	1.38
7o4e	540	41.66	6.14	8	53	-1.28	3.11
7e4o	187	43.63	6.12	11	53	-2.03	6.72
7e4o (D)	73	36.84	10.59	8	49	-1.34	0.88

Table 9

Descriptive Statistics:
Occupational Knowledge Test
OKT

TEST VERSION	N	MEAN	S.D.	MIN	MAX	SKEWNESS	KURTOSIS
102A	41	44.37	10.55	26	67	-0.06	-0.88
102B	223	35.37	8.92	15	57	0.19	-0.67
102C	41	46.15	12.70	19	72	-0.10	-0.28
102D	125	41.11	11.96	14	71	0.14	-0.61
102E	222	50.96	13.57	6	87	-0.31	0.27
102F	587	46.41	13.61	7	80	-0.23	-0.42
102G	170	52.43	15.12	10	81	-0.35	-0.68
102H	547	51.80	14.78	4	80	-0.50	-0.45
101B	138	65.54	16.41	24	89	-0.62	-0.51
101C	400	41.82	9.59	12	58	-0.65	-0.17

Table 10

Test Scores by Option

	<u>ENROUTE</u> (N=982)		<u>TERMINAL</u> (N=1006)		<u>t-TEST</u>	
	MEAN	S.D.	MEAN	S.D.	t	p
MCAT1	38.15	7.38	37.02	7.33	3.44	< .001
MCAT2	42.94	6.15	42.67	6.47	0.95	ns
OKT	54.38	19.42	55.43	18.23	1.24	ns

ns = nonsignificant

The two Options had average test scores that were found not to differ statistically for the MCAT2 and the OKT.

Subjects' test scores, as grouped by educational levels (high school, some college, and college graduate), are presented in Table 11. Those subjects with greater educational background appeared to score higher than those with only high school educations. High school graduates had the lowest mean score for the MCAT1 ($\bar{X} = 37.05$), subjects with some college background scored only slightly higher ($\bar{X} = 37.36$), and college graduates received the highest mean score of all three groups ($\bar{X} = 38.01$). The same apparent relationship between education and test scores also held true for the MCAT2. The subjects with more education scored progressively higher on the MCAT1 and the MCAT2. The college graduates, however, had a lower mean score ($\bar{X} = 51.29$) than subjects in the other two categories for the OKT. This is graphically illustrated in Figure 2.

In the FAA request for comparison of Race, Caucasians had significantly higher scores than Blacks for both the MCAT1 ($t(1881) = 13.20, p < .001$) and MCAT2 ($t(1881) = 11.76, p < .001$). Each mean, standard deviation, and t-test is presented in Table 12. The scores from the OKT were not significantly different ($t(1881) = 0.16, p > 0.05$) across racial background. Of those tested, 63.4 percent successfully completed the ATC Academy. Sixty-four point nine percent of the Caucasians, and 43.4 percent of the Blacks, passed the school curricula (Table 13). There was a significant difference in the proportion of pass/fail between Caucasians and Blacks ($\chi^2(1) = 25.26, p < 0.001$). The Blacks incurred higher attrition/failure rate in the ATC Academy than the Caucasians.

The t-tests performed in Table 14 detected significant differences for the MCAT1, MCAT2 and OKT across the sexes. Table 15 presents the crosstabulation of success/failure by sex in the FAA/ATC Academy. Of the 63.2 percent who successfully completed instruction, 64.1 percent of the males and 58.6 percent of the females had graduated from the school. Although males as a group scored higher on the three selection tests than females, no significant difference in the proportion of pass/fail across sex was found ($\chi^2(1) = 3.74, p > 0.05$) for any of the tests.

Reliability. The internal consistency estimates of reliability were computed for MCAT1 (Table 16), MCAT2 (Table 17), and the OKT (Table 18). Cronbach's coefficient alpha, a measure of reliability (8), had an average value of 0.86 for MCAT1 (range: 0.80 to 0.91), 0.80 for MCAT2 (range 0.63 to 0.93), and 0.91 for OKT (range 0.85 to 0.94). The standardized item alpha had a similar calculated average value of 0.85 with MCAT1 (range: 0.77 to 0.91); MCAT2 with 0.81 average coefficient (range: 0.64 to 0.93); and OKT with a mean coefficient of 0.90 (range 0.84 to 0.94). The internal consistency appears quite adequate with the exception of MCAT2 Version 807a(B), which had a reliability coefficient of only 0.63

Equivalence of Tests. Analyses of variance (Tables 19 through 21) were calculated to investigate the comparability of the versions of the MCAT1, MCAT2, and OKT. For MCAT1, $F(9, 2484) = 29.28, p < .001$; for MCAT2, $F(9, 2484) = 34.4$,

Table 11
Test Scores by Education

	HIGH SCHOOL (N=251)		SOME COLLEGE (N=834)		COLLEGE (N=673)	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
MCAT1	37.05	7.53	37.38	7.48	38.01	7.14
MCAT2	42.18	6.45	42.69	6.24	43.18	6.43
OKT	58.38	17.34	58.58	18.95	51.29	19.28

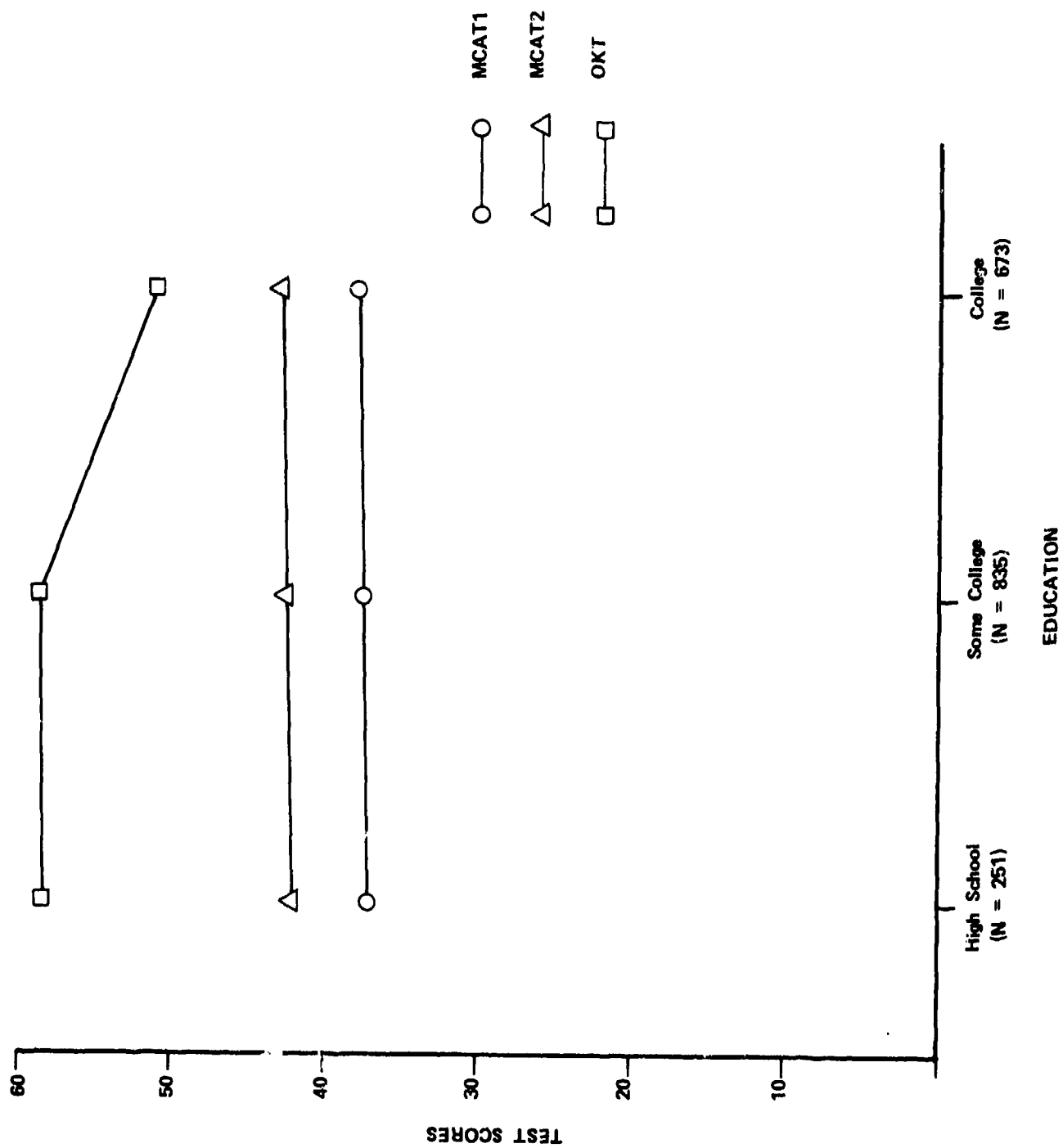


Figure 2. Mean test scores by education level

Table 12

Test Scores by Race*

	<u>CAUCASIAN</u> (N=1747)		<u>BLACK</u> (N=136)		<u>t-TESTS</u>	
	MEAN	S.D.	MEAN	S.D.	t	p
MCAT1	38.26	6.88	30.04	8.45	13.20	< .001
MCAT2	43.33	5.94	37.04	6.99	11.76	< .001
OKT	55.27	18.31	55.01	23.25	0.16	ns
ns = nonsignificant						

*Other minorities (N = 71): analysis not done.

Table 13
Success in FAA/ATC Academy
(By Race)

	CAUCASIAN	BLACK	TOTAL
PASS	1134 (95.1%) (64.9%)	59 (4.9%) (43.4%)	1193 (63.4%)
FAIL	613 (52.8%) (35.1%)	77 (11.2%) (56.6%)	690 (36.6%)

TOTAL	1747	136	1883
		Other Minorities = 71	
		Missing Data = 545	

Table 14

Test Scores by Sex Distribution

	<u>MALE</u> (N=1639)		<u>FEMALE</u> (N=348)		<u>t-TESTS</u>	
	MEAN	S.D.	MEAN	S.D.	<u>t</u>	<u>p</u>
MCAT1	37.94	7.18	35.88	8.03	4.76	.001
MCAT2	43.11	6.16	41.37	6.84	4.69	.001
OKT	55.50	18.88	52.10	18.37	3.07	.01

Table 15

Success in FAA/ATC Academy

	MALE	FEMALE	TOTAL
PASS	1051 (64.1%)	204 (58.6%)	1255 (63.2%)
FAIL	588 (35.9%)	144 (41.4%)	732 (36.8%)

Table 16

Multiplex Controller Aptitude Test - PART I
(MCAT1)

Reliability Coefficients

VERSION	CRONBACH ALPHA	STANDARDIZED ITEM ALPHA
4o6a	0.86	0.85
4e6o	0.88	0.88
6o7e	0.84	0.83
6e7o	0.81	0.78
6o7e (B)	0.85	0.85
6o7e (C)	0.80	0.77
6o7e (D)	0.91	0.91
7o4e	0.86	0.85
7e4o	0.87	0.87
7e4o (D)	0.91	0.91

Table 17

Multiplex Controller Aptitude Test - PART I
(MCAT2)

Reliability Coefficients

VERSION	CRONBACH ALPHA	STANDARDIZED ITEM ALPHA
4o6e	0.79	0.78
4e6o	0.81	0.83
6o7e	0.79	0.80
6e7o	0.81	0.80
6o7e (B)	0.63	0.64
6o7e (C)	0.80	0.84
6o7e (D)	0.83	0.85
7o4e	0.81	0.82
7e4o	0.83	0.85
7e4o (D)	0.93	0.93

Table 18
Occupational Knowledge Test
(OKT)

Reliability Coefficients

VERSION	CRONBACH ALPHA	STANDARDIZED ITEM ALPHA
102A	0.85	0.84
102B	0.90	0.90
102C	0.90	0.89
102D	0.90	0.90
102E	0.90	0.90
102F	0.91	0.90
102G	0.92	0.92
102H	0.92	0.92
101B	0.94	0.94
101C	0.90	0.91

Table 19

Analysis of Variance

Multiplex Controller Aptitude Test - Part I
(MCAT1)

SOURCE	df	MS	F	p
MCAT1	9	1083.09	29.28	< .001
ERROR	2484	36.99		

Table 20

Analysis of Variance

Multiplex Controller Aptitude Test - Part II
(MCAT2)

SOURCE	df	MS	F	p
MCAT2	9	1221.72	34.44	< .001
ERROR	1484	35.47		

Table 21
Analysis of Variance
Occupational Knowledge Test (102A-H)

SOURCE	df	MS	F	p
OKT	7	3837.67	20.05	.001
ERROR	1948	181.41		

$p < .001$; and the OKT (F value calculated for all versions of the OKT 102 test) was $F(7,1948) = p < .001$. There are statistically significant differences among the versions of the three FAA selection tests. It is possible that some differences among the test versions may be attributable to the subject distribution among the tests. The ratio of the number of subjects taking one test version as compared to another version was as high as 10 to 1 for MCAT1, MCAT2, and OKT (Tables 7, 8, and 9).

Item Analyses. Item difficulty; i.e., percentage of subjects who answered a question correctly, was calculated for each item for each version of each test. (Appendices A, B, and C). If it is assumed that the objective of the tests is to maximally discriminate among subjects, the test items that most subjects answer would not be very useful for selection purposes. Likewise, those test items that most subjects could not answer correctly would not be very useful selection items. It is assumed that items that over 80 percent of the subject population answer correctly and those items that under 20 percent of the subjects answer correctly are of little value for ATC selection purposes (9). Table 22 is a summary of Appendices A and B, which list the item difficulty for the MCAT1 and MCAT2. This table lists the total number of test items that over 80 percent or under 20 percent of the subjects answered correctly. Across all versions of the MCAT1, approximately 50 percent of all items have little selection utility. For the MCAT2 over 56 percent of items are considered very easy or very difficult. Table 23 is analogous to Table 22, providing the average test item difficulty for the OKT test versions. The percentage of test items that are of limited selective value is smaller for the OKT than for the MCAT. This finding is consistent with the premise that the OKT is more a measure of ATC job experience than a measure of cognitive capabilities related to ATC work.

Those subjects who had received the top 25 percent test scores were compared with those who were in the bottom 25 percent of that same test versions. The percentages of subjects answering the test item correctly were calculated for these groups. The difference between these two percentages provides an "index of discrimination" that is independent of sample size. This index can theoretically range between +100 and -100. The index of discrimination was calculated for each item of the MCAT1 (Appendix D), MCAT2 (Appendix E), and OKT (Appendix F). A summary of the means and ranges of the indices are found in Tables 24 through 26. The range of average indices was 27.93 to 38.62 for MCAT1; 19.05 to 45.88 for MCAT2; and 29.25 to 40.11 for the OKT.

Regression Analyses. Subjects were divided into two groups, namely Pass (those who had passed the ATC Academy) and Fail (those who attrited or academically failed the Academy). Regression analyses of each test or any possible combination thereof on this Pass/Fail variable were conducted. The regression of all three selection tests yielded the highest multiple linear regression coefficient ($R^2 = 0.117$) (Table 27). Each test variable was found to have beta weights that were statistically different from zero. MCAT1 = 0.012, MCAT2 = 0.012, OKT = 0.003 (Table 28).

The subjects were then divided into two further groups, male and female. Table 29 shows the R^2 for prediction of Academy Completion of males to be equal to

Table 22

Multiplex Controller Aptitude Test

Items Answered Correctly by Over 80 Percent
or
Under 20 Percent of the Subjects

VERSION	MCAT1	PERCENT OF TEST ITEMS	MCAT2	PERCENT OF TEST ITEMS
4o6e	26	47	29	53
4e6o	26	47	29	53
6o7e	28	51	37	67
6e7o	26	47	24	44
6o7e(B)	29	53	40	73
6o7e(C)	31	56	41	75
6o7e(D)	29	53	29	53
7o4e	23	42	29	53
7e4o	36	65	39	71
7e4o(D)	24	44	9	16
<u>AVERAGE</u>	27	51	31	56

Table 23

Occupational Knowledge Test

Items Answered Correctly by Over 80 Percent
or
Under 20 Percent of the Subjects

VERSION	<u>N</u>	PERCENT OF TEST ITEMS
101 B	35	35
101 C	22	37
102 A	22	22
102 B	19	19
102 C	25	25
102 D	17	17
102 E	21	21
102 F	19	19
102 G	18	18
102 H	19	19
<u>AVERAGE</u>	22	23

Table 24

Multiplex Controller Aptitude Test - Part I
(MCAT1)

Index of Discrimination

VERSION	MEAN	MINIMUM	MAXIMUM
4o6e	33.87	-4.32	85.57
4e6o	38.62	8.55	88.89
6o7e	33.33	-3.02	89.49
8e7o	29.49	-0.14	83.58
6o7e(B)	33.07	-2.63	84.21
6o7e(C)	27.93	-11.69	99.47
6o7e(D)	41.61	1.02	100.00
7o4e	39.34	0.86	88.43
7e4o	31.52	-2.18	81.48
7e4o(D)	38.03	-58.33	91.67

Table 25

Multiplex Controller Aptitude Test - Part II
(MGAT2)

Index of Discrimination

VERSION	MEAN	MINIMUM	MAXIMUM
4o8e	27.53	-11.50	75.06
4e8o	27.54	- 1.33	70.67
6o7e	19.05	-11.11	80.00
6e7o	27.04	-17.39	83.64
6o7e(B)	19.05	-11.11	80.00
6o7e(C)	23.16	-14.52	55.26
6o7e(D)	28.03	-11.04	85.71
7o4e	27.55	- 0.11	63.87
7e4o	23.53	- 1.96	65.38
7e4o(D)	45.88	-40.00	83.89

Table 26
Occupational Knowledge Test
Index of Discrimination

VERSION	MEAN	MINIMUM	MAXIMUM
102A	29.25	-24.44	90.00
102B	32.65	-37.17	77.38
102C	35.44	-30.00	86.89
102D	35.05	-17.10	77.20
102E	32.55	-23.24	75.04
102F	35.10	-37.03	81.12
102G	39.28	-30.83	83.04
102H	37.33	-11.66	77.98
101B	37.90	-52.33	88.57
101C	40.92	- 1.57	71.32

Table 27
Regression Models
for
Dependent Variable (Pass/Fail)

VARIABLES IN MODEL	<u>R</u> ²
MCAT1	.085
MCAT2	.079
OKT	.024
MCAT1 + MCAT2	.102
MCAT1 + OKT	.101
MCAT2 + OKT	.098
MCAT1 + MCAT2 + OKT	.117
(N = 1985)	

Table 28

Summary Multiple Linear Regression Predicting Pass/Fail

VARIABLE	COEFFICIENT	INCREASE R^2	$\underline{R^2}$	F	p
INTERCEPT	-0.507				
MCAT1	0.012	0.085	0.085	191.07	< .0001
MCAT2	0.012	0.017	0.102	37.51	< .001
OKT	0.003	0.015	0.117	33.47	< .0001

0.122. The multiple regression equation is as follows: (Pass/Fail) (Males) = (0.012) MCAT1 + (0.013) MCAT2 + (0.002) (OKT) -0.575, Table 29 shows all beta weights as statistically significant. For the females, $R^2 = 0.090$, but only MCAT1 had a beta weight that was statistically different from zero (Table 30). That is, MCAT2 and OKT were not able to add to the predictive power of the multiple regression equation for female ATC candidates.

Another division of the subject population was conducted for Caucasian and Black subgroupings. For the Caucasian subgroup $R^2 = 0.096$, and for the Black subgroup the $R^2 = 0.188$. Table 31 shows the F tests are significant for the three selection tests for the Caucasians. However, only the MCAT1 has a significant F test for the Black subgroup (Table 32).

DISCUSSION

Tests and Questionnaires. The ATC sample sizes and background data were satisfactory for the analyses. The distribution of subjects among Options (Table 4), Education (Table 5), and Experience (Table 6) is similar to that of the FAA 1969-1970, 1973-1974, and 1976 sample ATC populations (3). The total number of females and minorities participating in the study was equal to or greater than that of the previous studies combined (4). As had been found in FAA/ATC Specialists from 1969 to 1976 (10), females showed lower percentages of ATC or aviation experience prior to acceptance to the ATC Academy. This population sample had a greater proportion of subjects with continuing education beyond high school. The percentage of ATC Specialists with only a high school education was 34 percent in 1960-1970, 24 percent in 1973-1974, 18 percent in 1976 (11), and has further decreased to 14.3 percent in this 1978-1980 sample. Those subjects, on the other hand, who have a Bachelor Degree, have increased from 10 percent in 1969 to the present 38.3 percent in 1978-1980 (Table 5).

Test Scores. The subjects utilized in this study had already passed the CSC test selection battery before being administered the MCAT and OKT. This is reflected in the negatively skewed distribution of scores for most of the test versions. The increase of skew from MCAT1 to MCAT2 indicates that the test format was unique in that a learning process occurred during these short-times tests. Tables 7 and 8 indicate an increased mean test score from first to second presentation of the paper-and-pencil tests. A selection of personnel by improvement in test score between MCAT1 and MCAT2, rather than raw scores obtained for each test, may be a better predictive measure of ability to learn ATC job tasks. OKT distributions were not as negatively skewed as those of the MCAT, which may reflect greater differences among subjects with respect to ATC or ATC-related experience.

There appears to be a relationship between Education Level and selection test scores. The average MCAT scores were higher with increased education. This may indicate the measurement of general intelligence traits by the MCAT. The mean OKT score, however, is lower for the college graduates with respect to high school and Associate Degree subjects; i.e., college graduates have less Air Traffic Control experience than other applicants as measured by the OKT.

Table 29

Summary Multiple Linear Regression Predicting Pass/Fail
(Male)

VARIABLE	COEFFICIENT	F	p
INTERCEPT	-0.575		
MCAT1	0.012	157.23	< 0.0001
MCAT2	0.013	37.37	< 0.0001
OKT	0.003	33.36	< 0.0001
TOTAL R ² = .122			

Table 30

Summary Multiple Regression Predicting Pass/Fail
(Female)

VARIABLE	COEFFICIENT	<u>F</u>	<u>p</u>
INTERCEPT	-0.257		
MCAT1	0.013	30.18	< 0.0001
MCAT2	0.007	2.11	ns
OKT	0.002	1.75	ns
ns = nonsignificant		TOTAL R ² = 0.090	

Table 31

Summary Multiple Regression Predicting Pass/Fail
(Caucasian)

VARIABLE	COEFFICIENT	<u>F</u>	<u>p</u>
INTERCEPT	-0.465		
MCAT1	0.012	128.37	< 0.0001
MCAT2	0.011	27.84	< 0.0001
OKT	0.003	29.68	< 0.0001
		TOTAL R ² = 0.098	

Table 32

Summary Multiple Regression Predicting Pass/Fail
(Black)

VARIABLE	COEFFICIENT	<u>F</u>	<u>p</u>
INTERCEPT	0.642		
MCAT1	0.013	25.21	< 0.0001
MCAT2	0.016	3.79	ns
OKT	0.002	1.50	ns
ns = nonsignificant		TOTAL R^2 = 0.188	

It was found that the two minorities included in this study; i.e., Blacks and females, achieved significantly lower scores on the MCAT than Caucasians and males, respectively (Tables 12 and 14). The females as a group, however, while performing lower than males on the selection tests, did not have a higher rate of failure than the males (Table 15). The Black candidate's lower MCAT score, however, appears to correlate directly with a higher failure rate than that found for the Caucasians (Table 13).

Reliability. The internal consistency of the MCAT and the OKT is quite high. Most reliability coefficients are above 0.80 for the MCAT (Tables 16 and 17) and above 0.90 for the OKT (Table 18). The one unacceptable reliability coefficient for MCAT2, Version 6o7e(B), may in part be caused by the very low sample size of 42, which is the lowest of the 10 MCAT tests analyzed.

Equivalence of Tests. Analyses of variance (Tables 19 thru 21) show significant differences among the test versions of the MCAT1, MCAT2, and OKT, possibly in part due to the unequal sample sizes among the test versions. There may be a "non-random" distribution of subjects among the tests. The gender and race of the applicant have been shown to be related to test scores. A greater proportion of minorities taking one test version may in part account for significant test score differences. If Academy success is related to test scores, there may also be an overburdening of attrites in only a few of the test versions. As has been noted, there was an increased score from MCAT1 to MCAT2 for most subjects which was attributed to learning of the test scenarios. There may be a powerful order effect influencing test outcome. Table 3 shows that the test versions were not administered to counterbalance for any possible order effect. A comparison of tests with approximately equal subjects for counterbalanced versions to compensate for the Order Effect can determine if the tests are truly parallel.

Item Analyses. Items were found to be either too difficult or too easy for over 50 percent of the MCAT test. The OKT had a lower, more acceptable percentage, with all OKT 102 test versions having 25 or fewer percent easy/difficult items. Appendices A and B pinpoint the test items likely to need revision or elimination. For example, no subjects were able to answer Item #2, MCAT2, Test Version 6o7e(B). This question has no utility for selection of ATC personnel and thus should be modified or eliminated. Appendices D and E provide the relative discriminating power of each test item independent of sample size. For example, the index of discrimination for OKT Test Version 102A, Item #2, is -8.89, indicating that the bottom quartile subjects performed slightly better than the top quartile subjects. This item has a negative relationship to the OKT total test score. The relatively poor index of discrimination and large number of easily answered items may again be attributed to the preselected sample population. This does not, however, rule out the MCAT and OKT as appropriate selection tools, but rather indicates that more revisions of the test instruments are required.

Regression Analyses. Test scores for the MCAT1, MCAT2, and OKT did not have as high a predictive validity of success versus failure in the FAA/ATC student training program as previous pilot studies had indicated (2). Although the R^2 were low for all three tests, they were statistically significant at the $p < .001$ level (Table

28) . In view of the evidence that lower scores obtained by females, as opposed to males, did not mean higher female attrition rates, different multiple regression equations for prediction of ATC success rate had to be calculated. For the minorities (female and Black) the regression of MCAT2 and OKT onto the pass/fail criteria was not statistically significant. That is, MCAT2 and OKT do not add any more power to prediction of success for the minorities than MCAT1 alone.

The lower R^2 may be attributed to several intervening factors. They are: (1) possible nonrandom distribution of subjects among non-counterbalanced test versions; (2) the proportion of successful to attrite subjects departs from the ratio of 0.50/0.50 attenuating maximum possible correlation and thus maximum R^2 of selection test scores; and (3) the population samples were those persons who had already passed the FAA/ATC selection criteria. This should be considered as a nonrepresentative sample of all persons who might apply for ATC positions. This sample is preselected, as indicated by the skew and kurtosis of test results for the MCAT, with a resulting attenuation of R^2 .

SUMMARY

A study of prototype selection and prediction tests for Air Traffic Control personnel was conducted utilizing subjects entering the FAA Academy. Each subject was tested using two versions of the Multiplex Controller Aptitude Test (MCAT1 and MCAT2) and the Occupational Knowledge Test (OKT), providing 2,499 records for analysis.

Regression analysis indicated that the predictive validity for successful completion of the FAA ATC curriculum of the MCAT1, MCAT2, and OKT, was significant at the $p < .001$; however, the R^2 was low. Consideration of causes for the low R^2 includes nonuniform distribution of subjects and possible preselction as the population samples had passed the previous FAA/ATC entry criteria.

Item analyses indicated the MCAT contained very difficult or very easy items in over 50 percent of the questions. The OKT had acceptable levels of item difficulty at the 25 percent level.

Analyses of variance of the versions of each selection test MCAT1, MCAT2 and OKT indicated significant difference among the versions. The nonuniform-distribution of subjects and a learning effect between the test versions were considered as contributing to these differences.

Analyses, at the request of the FAA, of the education level, sex, and race for the prototype selection tests found that MCAT scores were higher with increased education, while the OKT were lower. Additionally, females scored lower than males, but did not have a higher attrition rate. Blacks had lower MCAT scores than Caucasians, which appeared to correlate directly with attrition.

RECOMMENDATIONS

Revision of the MCAT and OKT should be conducted to improve question or item utility for selection.

Evaluate test versions utilizing a random distribution with more uniform numbers of subjects participating in each test.

The learning process itself, between sequential tests such as the MCAT1 and MCAT2, may indicate the learning capability of the ATC applicant. The predictive value, utilizing the difference between test scores, should be further evaluated between series of tests.

Analysis of the predictive utility of the CSC ATC Aptitude Test, in conjunction with the MCAT/OKT, should be conducted to evaluate the cognitive characteristics required for successful ATC performance.

Application and evaluation of the prototype tests to include CSC, ASVAB, MCAT, and OKT, should be further evaluated prospectively utilizing U.S. Navy personnel considered for selection for ATC training.

REFERENCES

1. Brokaw, L. Historic Overview of Research and Development for Air Traffic Controller Selection. Paper presented at the Military Testing Association's 21st Annual Meeting, 14-19 October 1979.
2. Cobb, B. B., Mathews, J. J., and Nelson, P. L. Attrition-Retention Rates of Air Traffic Control Trainees Recruited During 1960-1963 and 1968-1970 FAA-AM-72-33, November 1972.
3. Federal Aviation Administration: Air Traffic Controller Selection and Retention Task Force Report, 20 December 1974.
4. Mies, J. M., Colman, J. G., and Demened, O. Predicting success of applicants for positions as Air Traffic Control Specialists in the Air Traffic Service. Washington, D.C., Education and Public Affairs, 8 May 1977.
5. TELECON NAMRL (Code 52) and Master Chief Pilgrim, Navy Air Traffic Controller School, Memphis, Tennessee, of 11 June 1980.
6. Pickrel, E. W., and Dailey, J. T. Development of the Multiple Controller Aptitude Test. Paper presented at the Military Testing Association's 21st Annual Meeting, 14-19 October 1979.
7. Pickrel, E. W. Development of Occupational Knowledge Tests for Enroute, Terminal and Flight Service Station Air Traffic Control Specialists.
8. Cronbach, L. J. Corefficient alpha and the internal structure of tests. Psychometrika, 1951, 16, 297-334.
9. Nunnally, J. C. Educational Measurement and Evaluation, McGraw-Hill Book Company, 1972.
10. Cobb, B. B., Nelson, P. L. Aircraft-Pilot and Other Pre-employment Experience as Factors in the Selection of Air Traffic Controller Trainees, FAA-AM-74-8, September 1974.
11. Cobb, B. B., Young, C. L., and Rezutti, B. L. Education as a Factor in the Selection of Air Traffic Controller Trainees. FAA-AM-76-6, June 1976.
12. Ghiselli, E. E., Campbell, J. P., and Zedeck, S. Measurement Theory for the Behavioral Sciences, W. H. Freeman & Company, 1981.

APPENDIX A
MULTIPLEX CONTROLLER APTITUDE TEST
ITEM DIFFICULTY
Part I

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

406e

PART: I

ITEM DIFFICULTY (% correct)

1	97.18	20	68.08	38	90.68
2	84.75	21	48.59	39	94.07
3	85.31	22	35.03	40	81.92
4	90.68	23	31.92	41	72.60
5	90.11	24	21.75	42	87.29
6	84.18	25	24.01	43	81.36
7	75.14	26	20.62	44	48.02
8	76.27	27	9.04	45	76.27
9	74.58	28	15.82	46	28.81
10	90.68	29	98.59	47	33.62
11	56.50	30	75.99	48	40.40
12	90.40	31	98.31	49	42.09
13	10.17	32	90.96	50	28.81
14	81.36	33	94.92	51	16.10
15	51.98	34	91.53	52	26.55
16	46.33	35	69.77	53	21.47
17	57.06	36	87.01	54	14.41
18	68.93	37	57.63	55	11.86
19	72.88				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

4e6o

PART: I

ITEM DIFFICULTY (% correct)

1	95.38	20	55.62	38	92.37
2	81.33	21	63.45	39	71.08
3	67.07	22	55.82	40	87.55
4	88.96	23	38.75	41	42.97
5	43.57	24	33.33	42	49.60
6	76.51	25	36.35	43	88.15
7	83.53	26	7.23	44	74.50
8	84.34	27	18.27	45	77.31
9	80.52	28	94.98	46	77.51
10	81.53	29	94.18	47	76.31
11	50.60	30	68.07	48	58.84
12	80.72	31	80.32	49	61.45
13	70.48	32	95.33	50	44.98
14	50.20	33	87.75	51	34.14
15	77.71	34	93.17	52	21.69
16	83.53	35	87.55	53	16.06
17	45.78	36	65.86	54	17.07
18	87.15	37	69.08	55	7.63
19	76.31				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

6o7e

PART: I

ITEM DIFFICULTY (% correct)

1	98.15	20	87.96	38	86.11
2	93.98	21	89.44	39	87.50
3	67.13	22	64.81	40	86.57
4	75.93	23	64.81	41	84.26
5	97.69	24	46.76	42	75.93
6	89.81	25	47.22	43	91.67
7	98.15	26	18.52	44	78.70
8	68.52	27	36.11	45	91.67
9	54.17	28	21.30	46	92.13
10	69.91	29	95.37	47	77.78
11	93.98	30	95.83	48	64.81
12	74.07	31	67.59	49	40.74
13	87.96	32	89.81	50	50.46
14	48.15	33	89.81	51	54.63
15	66.67	34	91.67	52	51.36
16	93.52	35	83.33	53	39.35
17	82.87	36	87.96	54	38.89
18	87.04	37	87.50	55	29.17
19	88.89				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

6e7a

PART: I

ITEM DIFFICULTY (% correct)

1	95.38	20	60.04	38	89.96
2	81.73	21	71.89	39	82.73
3	97.98	22	56.22	40	96.18
4	91.77	23	30.32	41	71.08
5	94.58	24	58.23	42	93.78
6	91.57	25	53.82	43	60.24
7	67.47	26	43.17	44	63.25
8	89.18	27	40.76	45	52.41
9	51.41	28	98.80	46	73.90
10	89.36	29	97.99	47	29.92
11	92.57	30	86.14	48	52.61
12	79.52	31	95.98	49	37.35
13	70.08	32	96.99	50	37.55
14	91.18	33	73.69	51	17.87
15	85.54	34	89.36	52	28.31
16	52.41	35	69.28	53	17.07
17	84.54	36	77.91	54	16.87
18	33.13	37	73.49	55	10.24
19	44.98				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

6o7e (b)

PART: I

ITEM DIFFICULTY (% correct)

1	96.55	20	88.97	38	89.86
2	98.62	21	68.97	39	93.10
3	59.31	22	73.79	40	84.83
4	73.10	23	68.28	41	86.21
5	95.86	24	55.17	42	77.24
6	93.79	25	50.34	43	91.03
7	97.24	26	22.76	44	81.38
8	71.03	27	5.52	45	38.97
9	55.86	28	26.21	46	91.03
10	66.90	29	90.34	47	79.31
11	93.79	30	94.48	48	74.48
12	60.00	31	65.52	49	46.21
13	85.52	32	77.93	50	53.79
14	45.52	33	86.21	51	0.00
15	56.55	34	91.72	52	60.69
16	91.03	35	85.52	53	48.28
17	86.21	36	85.52	54	42.07
18	86.21	37	91.03	55	30.34
19	86.90				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

8o7e(c)

PART: I

ITEM DIFFICULTY (% correct)

1	100.00	20	90.41	38	89.04
2	95.89	21	73.97	39	89.04
3	56.16	22	72.60	40	91.78
4	73.97	23	61.64	41	90.41
5	94.52	24	53.42	42	79.45
6	84.93	25	52.05	43	95.89
7	97.26	26	15.07	44	86.30
8	73.97	27	2.74	45	90.41
9	50.68	28	27.40	46	90.41
10	71.23	29	91.78	47	80.82
11	90.41	30	98.63	48	73.97
12	73.97	31	57.53	49	52.05
13	80.82	32	90.41	50	57.53
14	50.68	33	97.26	51	56.16
15	67.12	34	94.52	52	57.53
16	97.26	35	82.19	53	43.84
17	89.04	36	87.67	54	45.21
18	86.30	37	90.41	55	32.68
19	90.41				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

704a

PART: I

ITEM DIFFICULTY (% correct)

1	98.39	20	37.10	38	82.26
2	95.97	21	63.71	39	61.29
3	84.68	22	42.74	40	81.45
4	91.94	23	44.35	41	80.65
5	95.97	24	25.81	42	62.10
6	58.87	25	41.94	43	66.94
7	84.68	26	32.26	44	81.45
8	60.48	27	33.06	45	56.45
9	54.84	28	24.19	46	73.39
10	78.23	29	92.74	47	62.10
11	86.29	30	81.45	48	47.58
12	79.84	31	69.35	49	49.19
13	95.16	32	87.10	50	32.26
14	57.26	33	51.61	51	20.16
15	88.71	34	70.97	52	12.10
16	60.48	35	80.65	53	16.13
17	50.00	36	91.13	54	2.42
18	50.00	37	79.03	55	6.45
19	81.45				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

7e4o

PART: I

ITEM DIFFICULTY (% correct)

1	94.39	20	85.45	38	61.12
2	94.59	21	47.40	39	92.72
3	49.69	22	65.49	40	10.81
4	87.53	23	76.92	41	87.53
5	78.59	24	79.63	42	65.07
6	89.81	25	65.28	43	49.69
7	86.69	26	66.11	44	55.09
8	86.90	27	58.63	45	77.34
9	90.85	28	96.88	46	82.74
10	91.27	29	93.56	47	77.34
11	87.32	30	91.27	48	54.47
12	84.41	31	92.72	49	35.97
13	86.69	32	93.76	50	34.72
14	81.29	33	89.81	51	25.99
15	92.93	34	89.19	52	18.84
16	82.33	35	84.82	53	15.38
17	96.26	36	92.93	54	7.90
18	96.67	37	88.57	55	10.19
19	84.20				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

7e4o (D)

PART: I

ITEM DIFFICULTY (% correct)

1	89.58	20	54.17	38	68.75
2	93.75	21	33.33	39	87.50
3	47.92	22	50.00	40	12.50
4	72.92	23	47.92	41	75.00
5	68.75	24	18.67	42	62.50
6	60.42	25	31.25	43	37.50
7	83.33	26	27.08	44	58.33
8	75.00	27	10.42	45	68.75
9	72.92	28	93.75	46	66.67
10	91.67	29	87.50	47	70.83
11	81.25	30	87.50	48	31.25
12	72.92	31	87.50	49	25.00
13	79.17	32	87.50	50	31.25
14	72.92	33	72.92	51	12.50
15	72.92	34	79.17	52	10.42
16	83.33	35	89.58	53	10.42
17	50.00	36	81.25	54	4.17
18	83.33	37	81.25	55	6.25
19	79.17				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

6o7e(D)

PART: I

ITEM DIFFICULTY (% correct)

1	96.49	20	87.72	38	94.74
2	91.23	21	71.93	39	89.47
3	68.42	22	66.67	40	82.46
4	75.44	23	56.14	41	80.70
5	96.49	24	36.84	42	78.95
6	87.72	25	42.11	43	85.96
7	92.98	26	10.53	44	78.95
8	63.16	27	31.58	45	52.63
9	50.88	28	10.53	46	77.19
10	71.93	29	92.98	47	70.18
11	92.98	30	92.98	48	47.37
12	78.95	31	64.91	49	42.11
13	84.21	32	80.70	50	40.35
14	45.61	33	94.74	51	38.60
15	63.16	34	71.93	52	8.77
16	94.74	35	89.47	53	19.30
17	82.46	36	87.72	54	15.79
18	80.70	37	78.95	55	10.53
19	85.96				

APPENDIX B
MULTIPLEX CONTROLLER APTITUDE TEST
ITEM DIFFICULTY
PART II

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

4e6o

PART: II

ITEM DIFFICULTY (% correct)

1	96.52	20	66.09	38	97.39
2	94.78	21	85.22	39	66.96
3	88.09	22	81.74	40	90.43
4	89.57	23	61.74	41	51.30
5	58.26	24	61.74	42	40.87
6	75.65	25	74.78	43	96.52
7	88.96	26	23.48	44	86.96
8	87.83	27	60.00	45	88.70
9	91.30	28	94.78	46	88.70
10	88.96	29	94.78	47	92.17
11	60.87	30	69.57	48	78.26
12	87.83	31	85.22	49	82.61
13	75.65	32	97.39	50	71.30
14	70.43	33	87.83	51	57.39
15	80.00	34	94.78	52	49.57
16	94.78	35	92.17	53	31.30
17	53.91	36	64.35	54	47.83
18	95.65	37	71.30	55	38.26
19	87.83				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

406e

PART: II

ITEM DIFFICULTY (% correct)

1	97.96	20	93.62	38	87.24
2	90.56	21	73.47	39	96.68
3	92.60	22	54.34	40	85.71
4	96.17	23	64.29	41	75.00
5	94.13	24	59.18	42	94.13
6	85.20	25	63.01	43	89.29
7	86.99	26	72.19	44	53.83
8	81.38	27	48.21	45	85.46
9	91.84	28	66.84	46	38.78
10	91.33	29	96.94	47	39.29
11	59.18	30	75.26	48	66.84
12	87.76	31	98.98	49	80.36
13	12.50	32	92.35	50	58.42
14	63.67	33	94.39	51	39.54
15	57.40	34	96.17	52	71.94
16	48.47	35	70.41	53	61.22
17	65.05	36	85.20	54	49.74
18	86.48	37	57.65	55	46.43
19	96.17				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

607e

PART: II

ITEM DIFFICULTY (% correct)

1	98.60	20	97.32	38	91.59
2	96.94	21	77.96	39	91.21
3	67.01	22	81.53	40	90.45
4	82.04	23	80.00	41	89.81
5	98.34	24	70.57	42	80.25
6	91.08	25	79.75	43	95.54
7	96.82	26	26.75	44	87.01
8	88.41	27	74.65	45	96.82
9	67.01	28	56.69	46	97.45
10	73.38	29	93.76	47	87.13
11	94.90	30	95.80	48	82.93
12	72.61	31	62.80	49	55.67
13	91.08	32	85.35	50	70.45
14	57.71	33	93.89	51	80.89
15	55.41	34	94.90	52	83.69
16	96.69	35	84.59	53	74.65
17	90.19	36	88.15	54	74.39
18	90.32	37	93.38	55	62.68
19	95.92				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

6e7o

PART: II

ITEM DIFFICULTY (% correct)

1	97.27	20	71.04	38	89.07
2	84.70	21	90.16	39	79.23
3	97.81	22	73.22	40	96.72
4	90.16	23	53.01	41	66.67
5	96.17	24	88.52	42	96.17
6	91.80	25	79.23	43	52.46
7	73.77	26	68.31	44	72.13
8	87.98	27	77.60	45	48.63
9	60.66	28	98.36	46	89.07
10	91.80	29	38.91	47	36.61
11	99.45	30	82.51	48	68.31
12	9.84	31	97.27	49	59.56
13	73.22	32	95.08	50	62.84
14	94.54	33	72.13	51	38.25
15	74.32	34	94.54	52	51.37
16	53.55	35	67.21	53	39.34
17	90.71	36	79.78	54	37.16
18	43.72	37	74.86	55	25.14
19	47.54				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

6o7e (B)

PART: II

ITEM DIFFICULTY (% correct)

1	90.48	20	90.48	38	90.48
2	97.62	21	85.71	39	88.10
3	64.29	22	95.24	40	90.48
4	73.81	23	80.95	41	90.48
5	95.24	24	73.81	42	73.81
6	90.48	25	88.10	43	100.00
7	95.24	26	26.10	44	92.86
8	92.86	27	9.52	45	100.00
9	54.76	28	59.52	46	100.00
10	90.48	29	92.86	47	92.86
11	92.86	30	97.62	48	95.24
12	69.05	31	52.38	49	64.29
13	90.48	32	85.71	50	71.43
14	64.29	33	92.86	51	2.38
15	69.05	34	100.00	52	88.10
16	97.62	35	85.71	53	90.48
17	90.48	36	88.10	54	76.19
18	95.24	37	100.00	55	66.67
19	97.62				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

607e (C)

PART: II

ITEM DIFFICULTY (% correct)

1	100.00	20	98.29	38	82.05
2	100.00	21	78.63	39	90.60
3	75.21	22	88.03	40	34.62
4	69.23	23	82.91	41	93.16
5	98.29	24	70.09	42	80.34
6	91.45	25	88.03	43	97.44
7	94.87	26	35.04	44	88.89
8	94.02	27	12.82	45	99.15
9	65.91	28	72.65	46	97.44
10	77.78	29	96.58	47	83.76
11	93.16	30	94.02	48	86.32
12	65.81	31	64.96	49	61.54
13	88.03	32	88.03	50	80.34
14	52.99	33	92.31	51	89.74
15	50.43	34	94.87	52	92.31
16	94.02	35	83.76	53	89.74
17	89.74	36	88.03	54	84.62
18	93.16	37	95.73	55	77.78
19	94.87				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

6o7e(D)

PART: II

ITEM DIFFICULTY (% correct)

1	100.00	20	100.00	38	90.00
2	95.00	21	78.33	39	90.00
3	66.67	22	86.68	40	81.67
4	75.00	23	70.00	41	76.67
5	100.00	24	66.67	42	73.33
6	86.67	25	83.33	43	95.00
7	90.00	26	43.33	44	88.33
8	86.67	27	70.00	45	55.00
9	58.33	28	65.00	46	91.67
10	73.33	29	93.33	47	81.67
11	95.00	30	90.00	48	81.67
12	73.33	31	70.00	49	41.67
13	88.38	32	75.00	50	58.33
14	53.33	33	98.55	51	71.67
15	45.00	34	78.33	52	18.33
16	91.67	35	78.33	53	53.33
17	81.67	36	83.33	54	50.00
18	91.67	37	90.00	55	45.00
19	98.33				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

7e4o

PART: II

ITEM DIFFICULTY (% correct)

1	95.19	20	88.24	38	66.84
2	97.33	21	50.80	39	90.91
3	67.91	22	79.68	40	12.30
4	90.91	23	93.05	41	85.56
5	89.84	24	95.72	42	66.84
6	94.12	25	72.73	43	45.99
7	82.35	26	89.30	44	65.78
8	83.42	27	90.37	45	83.96
9	91.44	28	96.26	46	93.05
10	93.05	29	89.84	47	90.91
11	89.84	30	91.98	48	69.52
12	86.10	31	91.98	49	49.20
13	83.42	32	96.79	50	58.29
14	82.89	33	90.37	51	54.55
15	91.98	34	93.05	52	48.13
16	85.56	35	84.49	53	49.20
17	97.86	36	92.51	54	29.95
18	97.33	37	90.37	55	37.43
19	86.63				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

7o4e

PART: II

ITEM DIFFICULTY (% correct)

1	98.33	20	39.44	38	86.85
2	99.07	21	30.56	39	53.89
3	87.22	22	73.89	40	87.22
4	96.67	23	86.67	41	79.81
5	97.04	24	53.70	42	62.41
6	70.74	25	90.56	43	83.33
7	89.07	26	74.07	44	95.00
8	70.00	27	82.04	45	87.04
9	74.63	28	70.74	46	96.48
10	75.19	29	95.93	47	83.07
11	89.26	30	87.96	48	67.96
12	82.04	31	75.37	49	76.67
13	93.15	32	93.89	50	73.52
14	68.89	33	58.70	51	48.33
15	95.74	34	75.93	52	48.89
16	57.96	35	94.44	53	52.04
17	76.85	36	82.78	54	11.11
18	56.67	37	91.11	55	32.98
19	91.85				

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION:

7s4o (D)

PART: II

ITEM DIFFICULTY (% correct)

1	84.93	20	72.60	38	56.16
2	82.19	21	42.47	39	84.93
3	49.32	22	58.90	40	20.55
4	78.08	23	71.23	41	75.34
5	78.08	24	36.99	42	58.90
6	71.23	25	56.16	43	47.95
7	75.34	26	67.12	44	50.68
8	71.23	27	61.64	45	68.49
9	79.45	28	83.56	46	68.49
10	71.23	29	80.82	47	79.45
11	76.71	30	73.97	48	61.64
12	76.71	31	83.56	49	38.36
13	75.34	32	83.56	50	45.21
14	61.64	33	78.08	51	43.84
15	91.78	34	78.08	52	31.51
16	75.34	35	76.71	53	39.73
17	41.10	36	79.45	54	21.92
18	91.78	37	79.45	55	26.03
19	75.34				

APPENDIX C
OCCUPATIONAL KNOWLEDGE TEST
ITEM DIFFICULTY

OCCUPATIONAL KNOWLEDGE

VERSION: OKT 101B

ITEM DIFFICULTY (% correct)

1	98.55	26	71.74	51	81.88	76	39.86
2	76.09	27	57.25	52	59.42	77	42.75
3	24.64	28	.72	53	81.16	78	66.67
4	89.13	29	95.65	54	89.86	79	18.12
5	92.03	30	13.04	55	56.52	80	78.99
6	97.83	31	89.86	56	12.32	81	34.78
7	79.71	32	54.35	57	61.59	82	52.90
8	64.49	33	91.30	58	43.48	83	67.39
9	68.84	34	72.46	59	62.32	84	50.72
10	71.01	35	52.90	60	24.64	85	76.09
11	98.55	36	50.72	61	50.00	86	86.96
12	68.84	37	78.26	62	60.14	87	52.90
13	96.38	38	83.33	63	67.39	88	59.42
14	42.75	39	47.83	64	84.78	89	92.75
15	75.36	40	84.78	65	10.14	90	62.32
16	93.48	41	57.25	66	84.06	91	67.39
17	80.43	42	74.64	67	54.35	92	.72
18	82.61	43	70.29	68	17.39	93	83.33
19	84.78	44	78.26	69	88.41	94	31.88
20	69.57	45	63.77	70	59.42	95	76.81
21	89.13	46	22.46	71	38.41	96	69.57
22	66.67	47	67.39	72	66.67	97	61.59
23	81.16	48	89.13	73	50.00	98	18.84
24	47.83	49	92.75	74	56.52	99	62.32
25	3.62	50	92.03	75	10.14	100	4.35

OCCUPATIONAL KNOWLEDGE

VERSION: OKT 101C

ITEM DIFFICULTY (% correct)

1	99.25	21	95.00	41	81.50
2	83.00	22	81.25	42	78.50
3	97.00	23	48.25	43	54.00
4	96.50	24	42.00	44	67.00
5	89.75	25	81.50	45	93.75
6	63.50	26	87.00	46	63.75
7	78.25	27	N/A	47	66.75
8	98.25	28	56.75	48	56.25
9	61.50	29	71.50	49	38.00
10	94.50	30	69.75	50	79.50
11	49.50	31	85.00	51	74.75
12	74.25	32	61.75	52	65.75
13	82.25	33	88.75	53	79.00
14	85.25	34	91.50	54	63.50
15	69.75	35	47.25	55	91.00
16	91.50	36	39.50	56	75.00
17	80.25	37	59.25	57	67.25
18	38.50	38	26.50	58	72.25
19	63.00	39	48.75	59	61.25
20	62.75	40	57.25	60	53.25

OCCUPATIONAL KNOWLEDGE

VERSION: OKT 102A

ITEM DIFFICULTY (% correct)

1	80.49	26	19.51	51	63.41	76	46.34
2	12.20	27	53.66	52	85.37	77	75.61
3	36.59	28	58.54	53	39.02	78	14.63
4	26.83	29	70.73	54	43.90	79	60.98
5	24.39	30	68.29	55	24.39	80	75.61
6	78.05	31	2.44	56	24.39	81	34.15
7	58.54	32	78.05	57	73.17	82	4.88
8	51.22	33	56.10	58	63.41	83	34.15
9	68.29	34	63.41	59	31.71	84	73.17
10	56.10	35	34.15	60	73.17	85	48.78
11	60.98	36	58.54	61	46.34	86	60.98
12	82.93	37	51.22	62	48.78	87	31.71
13	48.78	38	58.54	63	36.59	88	19.51
14	34.15	39	34.15	64	26.83	89	56.10
15	53.66	40	26.83	65	46.34	90	36.59
16	31.71	41	78.05	66	39.02	91	14.63
17	31.71	42	60.98	67	19.51	92	9.76
18	73.17	43	31.71	68	29.27	93	39.02
19	19.51	44	29.27	69	24.39	94	12.20
20	29.27	45	73.17	70	63.41	95	53.66
21	80.49	46	39.02	71	56.10	96	51.22
22	75.61	47	12.20	72	12.20	97	63.41
23	26.83	48	39.02	73	46.34	98	34.15
24	31.71	49	31.71	74	60.98	99	17.07
25	85.37	50	9.76	75	9.76	100	63.41

OCCUPATIONAL KNOWLEDGE

VERSION: OKT 102B

ITEM DIFFICULTY (% correct)

1	77.13	26	53.81	51	63.68	76	50.22
2	79.37	27	53.81	52	61.43	77	39.46
3	9.87	28	68.16	53	46.64	78	64.13
4	42.15	29	77.58	54	74.44	79	26.01
5	50.22	30	28.70	55	55.61	80	84.75
6	68.61	31	33.18	56	8.97	81	38.57
7	19.28	32	60.54	57	22.42	82	12.11
8	59.64	33	42.15	58	39.01	83	47.98
9	23.77	34	62.33	59	36.32	84	57.40
10	52.91	35	74.89	60	70.40	85	38.57
11	19.28	36	11.66	61	14.35	86	48.88
12	43.95	37	13.00	62	35.43	87	20.63
13	42.60	38	1.79	63	24.22	88	34.08
14	51.12	39	29.60	64	61.43	89	13.90
15	37.67	40	43.05	65	60.54	90	25.56
16	60.54	41	42.15	66	46.19	91	5.38
17	35.87	42	20.63	67	31.84	92	29.60
18	26.46	43	25.56	68	86.55	93	37.67
19	53.36	44	39.91	69	58.30	94	40.36
20	71.30	45	25.11	70	64.57	95	46.64
21	60.09	46	29.60	71	70.85	96	35.87
22	50.22	47	46.19	72	6.28	97	51.12
23	21.08	48	33.63	73	17.04	98	32.29
24	55.61	49	52.91	74	36.77	99	26.01
25	89.89	50	36.77	75	10.31	100	34.53

OCCUPATIONAL KNOWLEDGE

VERSION: OKT 102C

ITEM DIFFICULTY (% correct)

1	70.73	26	26.83	51	53.66	76	60.98
2	29.27	27	92.68	52	2.44	77	17.07
3	36.59	28	48.78	53	31.71	78	39.02
4	26.83	29	75.61	54	2.44	79	29.27
5	34.15	30	34.15	55	31.71	80	53.66
6	68.29	31	7.32	56	29.27	81	43.90
7	17.07	32	75.61	57	63.41	82	73.17
8	100.00	33	24.39	58	48.78	83	92.68
9	90.24	34	56.10	59	75.61	84	19.51
10	41.46	35	65.85	60	36.59	85	21.95
11	31.71	36	78.05	61	51.22	86	19.51
12	85.37	37	78.05	62	73.17	87	40.78
13	24.39	38	31.71	63	7.32	88	65.85
14	56.10	39	78.05	64	63.41	89	65.85
15	65.85	40	58.54	65	31.71	90	63.41
16	12.20	41	36.59	66	12.20	91	51.22
17	78.05	42	60.98	67	39.02	92	39.02
18	60.98	43	82.93	68	29.27	93	2.44
19	48.78	44	39.02	69	12.20	94	73.17
20	29.27	45	43.90	70	63.41	95	53.66
21	97.56	46	19.51	71	46.34	96	46.34
22	80.49	47	36.59	72	68.29	97	46.34
23	97.56	48	17.07	73	68.29	98	0.00
24	48.78	49	56.10	74	51.22	99	46.34
25	53.66	50	26.83	75	14.63	100	48.78

OCCUPATIONAL KNOWLEDGE

VERSION: OKT 102D

ITEM DIFFICULTY (% correct)

1	24.00	26	51.20	51	61.60	76	72.80
2	36.80	27	33.60	52	92.80	77	43.20
3	56.00	28	51.20	53	49.60	78	60.00
4	81.60	29	36.00	54	20.80	79	28.80
5	38.40	30	64.80	55	44.00	80	39.20
6	55.20	31	38.40	56	16.00	81	5.60
7	42.40	32	76.80	57	41.60	82	36.00
8	39.20	33	14.40	58	56.00	83	13.60
9	46.40	34	80.80	59	69.60	84	39.20
10	45.60	35	26.40	60	48.00	85	48.80
11	48.80	36	51.20	61	48.00	86	51.20
12	78.40	37	20.80	62	72.00	87	33.60
13	60.00	38	33.60	63	34.40	88	40.00
14	72.00	39	82.40	64	41.60	89	26.40
15	56.00	40	95.20	65	40.00	90	34.40
16	53.60	41	34.40	66	1.60	91	44.80
17	52.00	42	88.80	67	31.20	92	36.00
18	64.80	43	36.00	68	48.00	93	61.60
19	80.80	44	16.80	69	52.00	94	28.00
20	29.60	45	41.60	70	87.20	95	17.60
21	20.00	46	28.80	71	34.40	96	48.60
22	12.00	47	11.20	72	47.20	97	26.40
23	20.80	48	68.00	73	29.60	98	47.20
24	36.00	49	54.40	74	85.60	99	32.80
25	26.40	50	44.00	75	76.80	100	56.80

OCCUPATIONAL KNOWLEDGE

VERSION: OKT 102F

ITEM DIFFICULTY (% correct)

1	15.50	26	75.81	51	36.63	76	17.55
2	9.71	27	20.78	52	78.53	77	41.74
3	9.03	28	60.31	53	58.09	78	56.56
4	30.49	29	46.00	54	37.82	79	50.43
5	51.45	30	54.68	55	65.42	80	23.00
6	58.94	31	60.65	56	51.11	81	48.69
7	23.34	32	43.27	57	30.66	82	23.34
8	88.76	33	63.88	58	14.99	83	28.62
9	58.60	34	11.58	59	42.76	84	56.39
10	55.54	35	60.48	60	42.93	85	24.36
11	35.95	36	50.60	61	72.06	86	28.11
12	68.43	37	36.46	62	13.12	87	70.70
13	73.08	38	83.48	63	26.92	88	44.79
14	46.68	39	64.22	64	56.90	89	68.65
15	59.28	40	66.27	65	83.30	90	65.76
16	39.52	41	12.44	66	76.83	91	59.45
17	62.18	42	14.82	67	81.09	92	30.66
18	25.21	43	15.16	68	48.72	93	9.03
19	51.79	44	78.53	69	42.25	94	62.86
20	53.15	45	84.84	70	33.39	95	26.24
21	20.44	46	75.13	71	24.70	96	55.03
22	59.63	47	42.08	72	19.42	97	53.83
23	92.16	48	31.86	73	36.29	98	46.85
24	29.30	49	41.23	74	35.09	99	56.39
25	33.05	50	36.63	75	87.05	100	18.06

OCCUPATIONAL KNOWLEDGE

VERSION: OKT 102 G

ITEM DIFFICULTY (% correct)

1	62.35	26	23.53	51	55.29	76	80.00
2	50.59	27	41.18	52	51.18	77	77.65
3	61.18	28	15.88	53	27.06	78	60.59
4	65.29	29	82.94	54	49.41	79	60.59
5	70.00	30	46.29	55	53.53	80	25.88
6	47.65	31	97.06	56	40.00	81	55.88
7	52.35	32	81.18	57	37.65	82	51.18
8	70.00	33	53.53	58	52.35	83	61.18
9	68.24	34	34.12	59	28.82	84	57.06
10	56.47	35	60.00	60	75.29	85	60.00
11	41.18	36	57.65	61	68.24	86	78.24
12	10.00	37	29.41	62	72.35	87	59.41
13	68.82	38	44.71	63	69.41	88	7.06
14	60.59	39	31.18	64	89.41	89	34.71
15	55.29	40	37.65	65	72.94	90	75.29
16	51.18	41	90.00	66	50.59	91	19.41
17	82.35	42	7.06	67	65.29	92	38.82
18	96.47	43	51.76	68	30.59	93	44.12
19	18.24	44	85.88	69	71.18	94	14.12
20	68.24	45	30.59	70	30.59	95	26.47
21	71.76	46	70.59	71	63.53	96	60.00
22	19.41	47	58.82	72	20.59	97	5.29
23	55.88	48	45.29	73	33.53	98	26.47
24	94.12	49	82.94	74	32.35	99	40.00
25	57.06	50	58.24	75	46.47	100	44.71

OCCUPATIONAL KNOWLEDGE

VERSION: OKT 102 H

ITEM DIFFICULTY (% correct)

1	59.60	26	41.50	51	50.64	76	33.27
2	58.68	27	64.53	52	29.80	77	72.94
3	50.64	28	92.14	53	15.90	78	53.02
4	24.68	29	18.46	54	46.62	79	33.82
5	65.63	30	33.64	55	35.83	80	42.60
6	55.39	31	77.88	56	49.53	81	23.40
7	10.42	32	75.87	57	34.00	82	34.00
8	87.57	33	36.56	58	72.03	83	30.53
9	63.80	34	75.69	59	48.81	84	72.21
10	77.15	35	94.15	60	70.93	85	70.57
11	84.64	36	90.86	61	33.27	86	42.60
12	24.13	37	63.44	62	69.84	87	25.05
13	17.37	38	63.07	63	38.03	88	69.29
14	24.13	39	96.89	64	89.21	89	46.98
15	47.35	40	75.69	65	77.88	90	77.15
16	52.29	41	70.75	66	53.75	91	70.93
17	59.05	42	45.16	67	77.70	92	22.12
18	29.62	43	51.01	68	79.16	93	48.63
19	87.39	44	8.23	69	78.43	94	61.06
20	88.30	45	74.41	70	82.82	95	29.07
21	56.86	46	29.43	71	58.14	96	16.09
22	44.61	47	19.56	72	60.15	97	41.32
23	33.27	48	56.12	73	64.17	98	3.47
24	58.68	49	47.71	74	21.39	99	39.85
25	25.23	50	48.08	75	35.83	100	9.51

OCCUPATIONAL KNOWLEDGE

VERSION: OKT 102 E

ITEM DIFFICULTY (% correct)

1	45.05	26	94.59	51	44.14	76	36.49
2	46.40	27	33.78	52	50.45	77	29.28
3	15.32	28	47.30	53	46.85	78	17.57
4	44.59	29	95.95	54	40.99	79	58.56
5	33.33	30	39.64	55	32.43	80	59.46
6	75.23	31	78.38	56	77.93	81	84.23
7	20.27	32	32.43	57	54.95	82	27.93
8	54.95	33	12.61	58	66.67	83	31.08
9	18.92	34	44.59	59	18.02	84	20.72
10	30.18	35	32.43	60	40.09	85	59.91
11	55.41	36	72.07	61	48.85	86	80.18
12	72.07	37	50.00	62	93.24	87	7.66
13	46.40	38	25.23	63	63.06	88	20.27
14	59.91	39	90.09	64	72.97	89	27.48
15	10.38	40	12.61	65	85.59	90	41.44
16	34.68	41	51.80	66	70.72	91	84.68
17	40.54	42	30.18	67	48.20	92	81.98
18	67.12	43	36.49	68	16.22	93	23.42
19	83.78	44	11.26	69	88.74	94	31.53
20	77.93	45	62.61	70	65.32	95	63.06
21	61.71	46	50.90	71	56.76	96	65.77
22	56.31	47	62.61	72	32.43	97	51.35
23	52.70	48	77.93	73	68.47	98	39.64
24	82.88	49	56.76	74	42.34	99	40.09
25	70.72	50	54.95	75	56.76	100	15.77

APPENDIX D:
MULTIPLEX CONTROLLER APTITUDE TEST
INDEX OF DISCRIMINATION
PART I

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 4e6o PART: I

INDEX OF DISCRIMINATION

1	8.55	29	14.53
2	18.80	30	21.36
3	17.10	31	32.48
4	16.24	32	14.53
5	24.79	33	12.82
6	19.65	34	12.82
7	31.63	35	17.10
8	20.52	36	32.48
9	28.20	37	36.75
10	17.95	38	18.81
11	33.34	39	21.37
12	29.06	40	27.35
13	20.52	41	17.95
14	39.31	42	27.35
15	29.06	43	40.17
16	41.03	44	41.88
17	39.32	45	64.10
18	45.30	46	70.94
19	64.11	47	73.51
20	58.12	48	75.21
21	70.08	49	88.89
22	81.20	50	86.32
23	68.38	51	78.64
24	65.81	52	58.12
25	73.51	53	34.19
26	14.53	54	48.72
27	48.72	55	17.10
28	13.67		

MULTIPLEX CONTROLLER AP'TITUDE TEST

VERSION: 4o6e PART: I

INDEX OF DISCRIMINATION

1	5.06	29	3.12
2	24.26	30	6.55
3	29.02	31	4.17
4	8.63	32	6.40
5	12.95	33	11.46
6	5.65	34	21.87
7	17.85	35	8.04
8	14.58	36	11.31
9	39.73	37	37.94
10	15.33	38	7.74
11	34.67	39	11.31
12	16.07	40	26.49
13	-4.32	41	20.53
14	28.42	42	18.90
15	19.02	43	44.35
16	26.19	44	38.69
17	47.02	45	56.10
18	73.51	46	39.58
19	59.53	47	60.27
20	77.08	48	72.62
21	69.34	49	85.57
22	67.26	50	68.45
23	63.99	51	40.92
24	56.39	52	62.80
25	58.77	53	57.58
26	46.13	54	40.78
27	25.15	55	32.44
28	29.46		

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 6o7e PART: I

INDEX OF DISCRIMINATION

1	6.00	29	3.74
2	12.00	30	6.00
3	2.34	31	24.98
4	17.11	32	18.00
5	0.00	33	15.74
6	9.74	34	17.74
7	-2.13	35	19.49
8	45.74	36	11.62
9	26.21	37	21.74
10	22.85	38	-3.02
11	8.00	39	3.11
12	23.62	40	23.87
13	18.00	41	15.36
14	5.06	42	19.11
15	28.85	43	26.00
16	19.87	44	45.62
17	27.62	45	27.87
18	27.87	46	27.87
19	38.00	47	53.87
20	39.87	48	67.36
21	55.36	49	66.34
22	71.74	50	64.34
23	61.36	51	85.74
24	52.09	52	83.62
25	79.23	53	83.23
26	25.66	54	89.49
27	74.72	55	72.60
28	45.19		

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 6e7o PART: I

INDEX OF DISCRIMINATION

1	3.79	29	-0.14
2	13.43	30	7.90
3	1.53	31	4.73
4	10.78	32	2.26
5	3.72	33	18.54
6	14.99	34	13.77
7	9.70	35	5.91
8	4.03	36	24.10
9	40.17	37	14.54
10	6.71	38	8.38
11	4.38	39	13.57
12	22.37	40	5.53
13	15.86	41	18.26
14	8.45	42	11.13
15	21.25	43	34.12
16	17.46	44	30.71
17	21.70	45	45.11
18	19.86	46	62.85
19	46.75	47	55.86
20	55.55	48	82.57
21	60.38	49	77.74
22	62.54	50	11.07
23	47.44	51	53.11
24	77.18	52	68.97
25	83.58	53	49.63
26	81.29	54	42.82
27	75.41	55	27.17
28	1.46		

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 607e(B) PART: I

INDEX OF DISCRIMINATION

1	2.63	29	18.43
2	2.63	30	15.79
3	18.42	31	39.47
4	31.58	32	21.05
5	7.89	33	26.32
6	0.00	34	13.16
7	0.00	35	-2.63
8	28.95	36	10.52
9	13.15	37	23.69
10	28.95	38	7.89
11	7.89	39	13.16
12	15.79	40	26.32
13	31.58	41	31.58
14	23.69	42	39.48
15	10.53	43	28.95
16	23.68	44	34.22
17	26.32	45	36.84
18	26.32	46	31.58
19	47.37	47	60.53
20	34.21	48	57.90
21	47.37	49	63.16
22	36.84	50	65.79
23	65.79	51	68.42
24	71.06	52	71.05
25	71.05	53	81.58
26	34.21	54	84.21
27	13.16	55	73.69
28	55.27		

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 6o7e(C) PART: I

INDEX OF DISCRIMINATION

1	0.00	29	20.76
2	-5.85	30	-5.56
3	35.67	31	30.41
4	-1.46	32	5.26
5	15.79	33	10.53
6	4.10	34	10.53
7	0.00	35	-11.69
8	25.44	36	-0.58
9	35.38	37	10.23
10	9.65	38	21.45
11	-0.30	39	20.76
12	4.38	40	15.49
13	25.73	41	10.23
14	29.53	42	20.47
15	14.91	43	15.79
16	-5.56	44	21.05
17	15.79	45	31.58
18	15.49	46	36.84
19	31.58	47	41.81
20	26.32	48	51.75
21	47.07	49	51.46
22	46.78	50	57.01
23	61.99	51	83.91
24	51.17	52	84.21
25	78.36	53	89.18
26	28.07	54	89.47
27	5.56	55	72.52
28	55.85		

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 6o7e(D) PART: I

INDEX OF DISCRIMINATION

1	7.69	29	15.38
2	15.38	30	15.38
3	33.85	31	61.54
4	16.41	32	46.15
5	15.38	33	15.38
6	23.08	34	32.82
7	8.71	35	9.75
8	40.52	36	16.41
9	42.56	37	38.46
10	48.21	38	15.38
11	1.02	39	38.46
12	31.79	40	31.79
13	24.10	41	53.85
14	12.82	42	53.85
15	49.23	43	30.77
16	24.08	44	61.54
17	53.85	45	56.92
18	53.85	46	69.23
19	31.79	47	76.92
20	38.46	48	93.33
21	61.54	49	72.31
22	92.31	50	66.67
23	100.00	51	86.67
24	80.00	52	20.00
25	85.64	53	46.67
26	18.98	54	40.00
27	57.95	55	26.67
28	26.67		

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 7o4e PART: I

INDEX OF DISCRIMINATION

1	4.00	29	12.43
2	4.86	30	24.00
3	21.29	31	19.43
4	0.86	32	32.86
5	12.00	33	16.71
6	22.14	34	26.14
7	13.29	35	60.00
8	19.43	36	16.43
9	31.43	37	37.29
10	17.71	38	25.29
11	8.43	39	35.43
12	9.71	40	25.29
13	12.00	41	29.29
14	31.43	42	32.29
15	28.00	43	61.71
16	23.00	44	60.00
17	28.71	45	85.71
18	35.86	46	72.43
19	64.00	47	88.00
20	53.14	48	74.14
21	72.43	49	88.43
22	56.14	50	75.00
23	74.14	51	49.14
24	52.71	52	38.86
25	73.29	53	46.00
26	52.29	54	10.71
27	63.00	55	17.43
28	53.14		

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 7e4o PART: I

INDEX OF DISCRIMINATION

1	15.20	29	7.12
2	9.54	30	21.58
3	18.20	31	10.32
4	19.92	32	7.90
5	25.34	33	20.72
6	19.10	34	19.94
7	14.20	35	19.00
8	17.46	36	19.40
9	15.12	37	22.34
10	12.66	38	34.59
11	26.38	39	11.10
12	19.84	40	-2.18
13	18.28	41	22.28
14	26.22	42	22.65
15	16.78	43	23.90
16	27.84	44	48.17
17	10.40	45	53.48
18	11.20	46	50.38
19	30.34	47	63.98
20	35.14	48	74.10
21	43.29	49	57.63
22	58.90	50	70.69
23	63.98	51	59.91
24	60.78	52	47.56
25	75.90	53	39.36
26	79.16	54	22.95
27	81.48	55	27.05
28	4.76		

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 7e4o(D) PART: I

INDEX OF DISCRIMINATION

1	41.67	29	33.33
2	16.67	30	41.67
3	16.66	31	16.67
4	58.33	32	41.67
5	25.00	33	41.67
6	50.00	34	50.00
7	16.67	35	-58.33
8	25.00	36	33.34
9	33.33	37	50.00
10	25.00	38	50.00
11	25.00	39	33.33
12	33.33	40	-8.33
13	75.00	41	58.34
14	75.00	42	75.00
15	50.00	43	58.33
16	58.33	44	58.33
17	33.33	45	91.6
18	33.33	46	83.33
19	50.00	47	83.33
20	75.00	48	58.33
21	50.00	49	58.33
22	75.00	50	-8.34
23	75.00	51	16.67
24	0.00	52	0.00
25	58.34	53	-8.34
26	41.67	54	8.33
27	8.34	55	-16.67
28	25.00		

APPENDIX E:
MULTIPLEX CONTROLLER APTITUDE TEST
INDEX OF DISCRIMINATION
PART II

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION 4e6o PART II

INDEX OF DISCRIMINATION

1	3.33	27	68.67	53	26.00
2	9.33	28	10.00	54	70.67
3	30.00	29	10.00	55	28.67
4	20.00	30	11.33		
5	12.00	31	22.00		
6	17.33	32	3.33		
7	36.67	33	0.67		
8	22.67	34	16.67		
9	19.33	35	10.00		
10	5.33	36	27.33		
11	12.67	37	20.67		
12	19.33	38	3.33		
13	39.33	39	4.00		
14	45.33	40	20.00		
15	12.00	41	16.67		
16	-1.33	42	19.33		
17	35.33	43	6.67		
18	6.67	44	36.67		
19	26.00	45	30.00		
20	54.00	46	33.33		
21	40.00	47	30.00		
22	46.00	48	32.00		
23	50.00	49	53.33		
24	43.33	50	58.67		
25	60.00	51	79.33		
26	37.33	52	63.33		

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 406e PART: II

INDEX OF DISCRIMINATION

1	4.90	29	5.72
2	5.10	30	9.42
3	10.48	31	1.96
4	4.90	32	13.57
5	4.27	33	9.49
6	16.20	34	7.53
7	15.22	35	25.11
8	24.20	36	16.04
9	12.28	37	34.13
10	20.59	38	13.77
11	27.31	39	6.86
12	9.85	40	18.47
13	-11.50	41	35.54
14	24.40	42	3.29
15	45.24	43	16.04
16	20.70	44	13.32
17	25.51	45	33.02
18	15.88	46	32.62
19	10.62	47	42.58
20	19.61	48	57.89
21	38.64	49	45.45
22	21.32	50	61.19
23	43.07	51	48.93
24	59.89	52	63.73
25	49.78	53	70.94
26	59.64	54	75.06
27	58.96	55	53.43
28	61.97		

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 607e PART: II

INDEX OF DISCRIMINATION

1	2.43	30	4.43
2	4.38	31	24.73
3	17.82	32	23.52
4	15.00	33	12.15
5	1.96	34	9.26
6	8.02	35	17.30
7	3.92	36	17.60
8	23.43	37	14.58
9	30.66	38	4.50
10	22.53	39	16.59
11	6.85	40	14.19
12	25.30	41	21.45
13	13.18	42	28.90
14	24.98	43	12.15
15	25.04	44	25.37
16	7.30	45	8.75
17	15.62	46	8.25
18	20.44	47	22.06
19	9.24	48	29.81
20	0.60	49	48.43
21	28.01	50	50.81
22	29.33	51	51.53
23	23.66	52	46.64
24	41.26	53	55.52
25	43.85	54	61.25
26	20.29	55	61.62
27	52.56		
28	47.94		
29	13.12		

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 6o7e(B) PART: II

INDEX OF DISCRIMINATION

1	20.00	30	0.00
2	10.00	31	27.78
3	50.00	32	30.00
4	20.00	33	10.00
5	0.00	34	0.00
6	20.00	35	10.00
7	0.00	36	28.89
8	-1.11	37	0.00
9	45.56	38	10.00
10	10.00	39	10.00
11	-11.11	40	20.00
12	27.78	41	30.00
13	30.00	42	47.78
14	38.89	43	0.00
15	6.67	44	-11.11
16	10.00	45	0.00
17	10.00	46	0.00
18	10.00	47	20.00
19	10.00	48	10.00
20	20.00	49	-3.33
21	30.00	50	17.78
22	20.00	51	11.11
23	40.00	52	40.00
24	50.00	53	40.00
25	20.00	54	80.00
26	13.33	55	80.00
27	-8.89		
28	27.78		
29	20.00		

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 607e(B) PART: II

INDEX OF DISCRIMINATION

1	20.00	30	0.00
2	10.00	31	27.78
3	50.00	32	30.00
4	20.00	33	10.00
5	0.00	34	0.00
6	20.00	35	10.00
7	0.00	36	28.89
8	-1.11	37	0.00
9	45.56	38	10.00
10	10.00	39	10.00
11	-11.11	40	20.00
12	27.78	41	30.00
13	30.00	42	47.78
14	38.89	43	0.00
15	6.67	44	-11.11
16	10.00	45	0.00
17	10.00	46	0.00
18	10.00	47	20.00
19	10.00	48	10.00
20	20.00	49	-3.33
21	30.00	50	17.78
22	20.00	51	11.11
23	40.00	52	40.00
24	50.00	53	40.00
25	20.00	54	80.00
26	13.33	55	80.00
27	-8.89		
28	27.78		
29	20.00		

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 607e(C) PART: II

INDEX OF DISCRIMINATION

1	0.00	28	28.44
2	0.00	29	11.11
3	21.04	30	11.11
4	28.15	31	51.26
5	3.70	32	25.63
6	-4.30	33	22.22
7	11.11	34	11.11
8	14.81	35	40.74
9	46.96	36	29.63
10	10.22	37	11.11
11	-0.59	38	10.22
12	32.15	39	18.22
13	21.93	40	25.63
14	38.96	41	22.22
15	42.37	42	21.33
16	18.52	43	7.41
17	18.22	44	25.63
18	21.93	45	3.70
19	18.52	46	11.11
20	3.70	47	29.33
21	44.15	48	37.04
22	29.63	49	42.67
23	36.44	50	40.74
24	55.26	51	25.93
25	25.93	52	18.22
26	38.37	53	33.33
27	-14.52	54	48.15
		55	47.85

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 6c7e (D), PART II

1	0.00	28	46.11
2	14.92	29	28.27
3	22.73	30	21.43
4	40.91	31	22.73
5	0.00	32	48.05
6	12.34	33	7.14
7	-11.04	34	26.62
8	28.57	35	- 9.74
9	18.84	36	8.44
10	38.96	37	28.57
11	7.14	38	5.20
12	24.68	39	28.57
13	21.3	40	26.62
14	25.38	41	38.96
15	16.88	42	33.77
16	19.48	43	14.29
17	35.71	44	12.34
18	35.71	45	37.02
19	7.14	46	35.71
20	0.00	47	42.86
21	19.48	48	40.91
22	19.48	49	42.21
23	38.96	50	53.25
24	29.87	51	78.57
25	55.20	52	31.16
26	24.02	53	62.34
27	27.93	54	85.71
		55	69.48

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 7o4e PART: II

INDEX OF DISCRIMINATION

1	3.73	30	15.26
2	-0.11	31	16.68
3	12.39	32	11.83
4	5.74	33	21.44
5	5.22	34	25.88
6	19.33	35	14.93
7	15.95	36	16.53
8	32.59	37	17.68
9	28.00	38	25.02
10	27.83	39	48.60
11	18.31	40	10.78
12	22.95	41	34.61
13	4.48	42	49.24
14	37.35	43	22.61
15	12.57	44	15.67
16	27.87	45	24.79
17	20.30	46	12.69
18	23.39	47	29.10
19	20.15	48	38.45
20	30.38	49	42.24
21	35.64	50	61.48
22	40.11	51	63.87
23	27.15	52	56.06
24	58.02	53	51.93
25	33.47	54	12.13
26	48.32	55	51.21
27	49.77		
28	55.56		
29	8.10		

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 7e4o PART: II

INDEX OF DISCRIMINATION

1	11.54	30	15.38
2	-1.93	31	9.61
3	17.31	32	3.85
4	9.61	33	15.39
5	19.23	34	19.23
6	11.54	35	28.84
7	25.00	36	13.46
8	19.23	37	21.15
9	17.31	38	26.92
10	1.92	39	7.69
11	13.46	40	0.00
12	25.00	41	30.77
13	23.08	42	26.93
14	21.15	43	7.69
15	19.23	44	44.23
16	28.84	45	38.46
17	7.69	46	23.08
18	7.69	47	30.77
19	23.08	48	46.08
20	15.39	49	44.23
21	28.85	50	65.38
22	40.38	51	65.38
23	17.31	52	61.54
24	15.38	53	61.54
25	26.92	54	42.31
26	19.23	55	44.23
27	23.08		
28	-1.96		
29	13.46		

MULTIPLEX CONTROLLER APTITUDE TEST

VERSION: 7e4o(D) PART: II

INDEX OF DISCRIMINATION

1	44.44	28	50.56
2	39.44	29	51.11
3	- 5.00	30	56.11
4	1.67	31	50.56
5	50.00	32	50.00
6	12.78	33	72.22
7	40.00	34	72.22
8	61.67	35	39.44
9	66.67	36	77.78
10	66.67	37	61.11
11	45.56	38	52.78
12	51.11	39	44.44
13	50.56	40	- 40.00
14	72.78	41	40.00
15	16.67	42	40.56
16	61.11	43	5.00
17	48.89	44	5.00
18	17.78	45	83.89
19	77.78	46	78.89
20	77.78	47	55.56
21	58.89	48	67.78
22	68.89	49	48.33
23	77.78	50	53.33
24	1.11	51	48.89
25	79.44	52	23.89
26	51.67	53	6.67
27	83.89	54	3.89
		55	13.33

APPENDIX F:
OCCUPATIONAL KNOWLEDGE TEST
INDEX OF DISCRIMINATION

OCCUPATIONAL KNOWLEDGE TEST

VERSION: 101B

INDEX OF DISCRIMINATION

1	2.86	30	-18.03	59	44.81	88	82.12
2	39.26	31	25.71	60	25.16	89	20.00
3	34.47	32	78.89	61	42.76	90	53.18
4	19.26	33	28.57	62	67.48	91	59.26
5	22.86	34	49.98	63	38.53	92	-2.86
6	5.71	35	39.54	64	42.48	93	33.91
7	51.43	36	72.44	65	-22.48	94	62.03
8	23.51	37	62.48	66	36.77	95	44.98
9	46.73	38	51.43	67	67.48	96	60.00
10	38.53	39	-52.33	68	-16.41	97	88.57
11	5.71	40	27.84	69	37.14	98	8.29
12	50.32	41	15.95	70	43.87	99	52.81
13	11.43	42	2.40	71	41.86	100	-2.48
14	56.68	43	65.34	72	38.53		
15	53.91	44	65.34	73	26.63		
16	22.86	45	46.36	74	43.51		
17	42.48	46	49.13	75	-11.43		
18	30.32	47	70.89	76	35.20		
19	57.14	48	40.00	77	53.83		
20	71.08	49	25.71	78	50.89		
21	34.29	50	13.91	79	-22.12		
22	53.55	51	36.77	80	39.26		
23	62.86	52	82.12	81	43.77		
24	72.08	53	42.48	82	45.82		
25	-5.71	54	14.29	83	77.14		
26	82.86	55	64.24	84	48.85		
27	67.48	56	-22.48	85	51.08		
28	3.23	57	88.57	86	22.48		
29	8.57	58	51.33	87	51.33		

OCCUPATIONAL KNOWLEDGE TEST

VERSION: 101C

INDEX OF DISCRIMINATION

1	3.06	30	60.10	59	56.87
2	22.34	31	54.06	60	61.97
3	11.22	32	49.69		
4	10.18	33	25.45		
5	19.33	34	25.47		
6	33.33	35	63.81		
7	42.82	36	33.91		
8	5.10	37	42.51		
9	55.85	38	49.11		
10	17.35	39	64.90		
11	0.00	40	45.41		
12	60.15	41	49.98		
13	37.74	42	43.82		
14	53.06	43	61.93		
15	62.21	44	63.18		
16	30.61	45	11.19		
17	55.10	46	22.01		
18	63.80	47	43.62		
19	62.03	48	31.10		
20	64.07	49	39.99		
21	11.20	50	39.71		
22	34.61	51	41.65		
23	51.55	52	60.06		
24	66.98	53	39.67		
25	29.46	54	71.32		
26	33.63	55	29.59		
27	48.25	56	47.90		
28	22.79	57	53.90		
29	- 1.57	58	65.29		

OCCUPATIONAL KNOWLEDGE TEST

VERSION: 102A

INDEX OF DISCRIMINATION

1	-8.89	30	77.78	59	50.00	88	40.00
2	8.89	31	0.00	60	68.67	89	46.67
3	5.56	32	44.44	61	46.67	90	58.89
4	18.89	33	36.67	62	15.56	91	30.00
5	-2.22	34	15.56	63	16.67	92	8.89
6	77.78	35	6.67	64	27.78	93	38.89
7	27.78	36	26.67	65	36.67	94	30.00
8	-15.56	37	15.56	66	57.78	95	73.89
9	45.56	38	46.67	67	-2.22	96	26.67
10	47.78	39	-13.33	68	60.00	97	34.44
11	15.56	40	7.78	69	-4.44	98	80.00
12	23.33	41	23.33	70	34.44	99	50.00
13	15.56	42	4.44	71	35.56	100	67.78
14	-3.33	43	27.78	72	-1.11		
15	37.78	44	-2.22	73	47.78		
16	47.78	45	55.56	74	-6.67		
17	-24.44	46	-24.44	75	20.00		
18	12.22	47	-11.11	76	40.00		
19	-12.22	48	47.78	77	45.56		
20	20.00	49	27.78	78	-2.22		
21	12.22	50	10.00	79	35.56		
22	67.78	51	45.56	80	55.56		
23	70.00	52	55.56	81	7.78		
24	48.89	53	90.00	82	-11.11		
25	23.33	54	26.67	83	28.89		
26	7.78	55	50.00	84	44.44		
27	77.78	56	-13.33	85	37.78		
28	46.67	57	-6.67	86	57.78		
29	24.44	58	66.67	87	37.78		

OCCUPATIONAL KNOWLEDGE TEST

VERSION: 102B

INDEX OF DISCRIMINATION

1	29.98	30	32.49	59	48.00	88	39.38
2	10.80	31	44.62	60	38.78	89	-0.30
3	6.75	32	38.99	61	30.97	90	27.31
4	27.26	33	14.81	62	23.68	91	-3.57
5	61.73	34	26.77	63	22.08	92	53.32
6	49.43	35	21.32	64	49.33	93	51.43
7	-5.51	36	-3.72	65	49.37	94	74.01
8	47.73	37	-3.72	66	16.61	95	66.97
9	16.94	38	-3.51	67	8.08	96	61.92
10	66.94	39	27.34	68	35.09	97	42.56
11	8.50	40	-0.82	69	40.71	98	51.48
12	20.02	41	-37.17	70	7.53	99	44.70
13	37.42	42	17.03	71	26.53	100	39.38
14	37.30	43	30.79	72	1.57		
15	22.05	44	39.32	73	3.15		
16	47.70	45	34.30	74	18.42		
17	53.30	46	16.91	75	4.99		
18	41.17	47	33.97	76	51.36		
19	49.58	48	15.10	77	34.02		
20	49.27	49	35.51	78	54.54		
21	37.20	50	35.75	79	18.75		
22	48.66	51	56.33	80	24.60		
23	-0.36	52	54.57	81	44.49		
24	39.08	53	49.49	82	10.20		
25	36.84	54	59.68	83	44.37		
26	66.82	55	58.08	84	54.63		
27	70.29	56	-10.62	85	67.15		
28	63.28	57	16.97	86	77.38		
29	57.95	58	42.77	87	30.91		

OCCUPATIONAL KNOWLEDGE TEST

VERSION: 102C

INDEX OF DISCRIMINATION

1	38.89	29	17.78	57	47.78	85	24.44
2	14.44	30	3.33	58	78.89	86	12.22
3	67.78	31	1.11	59	70.00	87	88.89
4	13.33	32	48.89	60	88.89	88	58.89
5	56.87	33	3.33	61	78.89	89	80.00
6	50.00	34	70.00	62	70.00	90	90.00
7	34.44	35	27.78	63	11.11	91	47.78
8	0.00	36	40.00	64	18.89	92	88.89
9	10.00	37	38.89	65	24.44	93	-10.00
10	15.56	38	34.44	66	-10.00	94	70.00
11	4.44	39	18.89	67	37.78	95	77.78
12	40.00	40	- 4.44	68	24.44	96	77.78
13	14.44	41	4.44	69	- 8.89	97	78.89
14	27.78	42	38.89	70	48.89	98	67.78
15	48.39	43	- 1.11	71	57.78	99	88.89
16	33.33	44	- 7.78	72	48.89	100	39.38
17	40.00	45	67.78	73	50.00		
18	50.00	46	1.11	74	4.44		
19	57.78	47	5.56	75	22.22		
20	14.44	48	23.33	76	68.89		
21	0.00	49	48.87	77	22.22		
22	70.00	50	44.44	78	-16.67		
23	00	51	26.87	79	-30.00		
24	78.89	52	0.00	80	5.56		
25	47.78	53	12.22	81	67.78		
26	55.56	54	-10.00	82	60.00		
27	10.00	55	14.44	83	30.00		
28	47.78	56	77.78	84	23.33		

OCCUPATIONAL KNOWLEDGE TEST

VERSION: 102D

INDEX OF DISCRIMINATION

1	36.99	30	28.39	59	58.06	88	57.20
2	14.30	31	40.75	60	57.32	89	53.33
3	5.06	32	12.48	61	54.19	90	60.43
4	9.03	33	10.22	62	51.61	91	70.32
5	10.75	34	15.70	63	36.99	92	66.99
6	5.27	35	14.09	64	17.52	93	70.54
7	57.20	36	50.97	65	50.75	94	63.44
8	34.30	37	20.43	66	0.10	95	6.99
9	44.41	38	34.09	67	60.43	96	67.10
10	-14.04	39	-17.10	68	47.64	97	-15.91
11	31.19	40	-0.10	69	60.75	98	60.43
12	-3.87	41	43.77	70	29.03	99	17.42
13	37.96	42	25.70	71	37.10	100	50.75
14	41.61	43	24.30	72	50.65		
15	51.29	44	7.32	73	20.54		
16	70.75	45	53.87	74	35.38		
17	67.52	46	10.86	75	57.96		
18	70.97	47	-12.80	76	51.51		
19	61.29	48	41.61	77	67.10		
20	-2.48	49	17.96	78	63.77		
21	40.22	50	18.06	79	50.22		
22	-9.46	51	51.07	80	21.07		
23	17.10	52	29.03	81	20.00		
24	34.09	53	21.39	82	63.33		
25	33.65	54	3.98	83	33.55		
26	47.52	55	33.98	84	53.77		
27	-2.36	56	-9.25	85	54.09		
28	21.39	57	34.30	86	76.99		
29	34.30	58	77.20	87	66.99		

OCCUPATIONAL KNOWLEDGE TEST

VERSION: 102E

INDEX OF DISCRIMINATION

1	15.81	30	-11.34	59	6.57	88	15.41
2	-30.72	31	19.47	60	56.02	89	42.56
3	0.99	32	26.69	61	65.24	90	23.79
4	20.77	33	16.86	62	22.03	91	33.77
5	33.84	34	65.00	63	37.38	92	38.86
6	12.45	35	30.94	64	29.77	93	22.93
7	-5.70	36	52.29	65	25.06	94	19.41
8	63.79	37	56.27	66	34.49	95	51.80
9	-23.24	38	58.56	67	36.27	96	59.07
10	9.00	39	28.81	68	38.56	97	49.62
11	57.01	40	8.01	69	23.48	98	57.10
12	36.42	41	49.37	70	47.92	99	75.04
13	8.41	42	19.41	71	42.71	100	43.88
14	46.35	43	58.92	72	39.30		
15	13.10	44	2.69	73	9.89		
16	-11.21	45	42.84	74	-1.04		
17	22.35	46	67.06	75	38.96		
18	46.97	47	32.54	76	42.69		
19	44.07	48	45.51	77	33.71		
20	42.12	49	49.86	78	4.75		
21	63.92	50	19.32	79	59.91		
22	49.74	51	24.16	80	33.99		
23	24.90	52	52.63	81	44.07		
24	28.32	53	34.70	82	44.38		
25	26.13	54	66.32	83	30.32		
26	9.92	55	-1.29	84	6.57		
27	46.32	56	3.73	85	63.42		
28	29.49	57	15.81	86	40.31		
29	4.96	58	64.16	87	-4.72		

OCCUPATIONAL KNOWLEDGE TEST

VERSION: 102F

INDEX OF DISCRIMINATION

1	8.20	30	67.94	59	36.89	88	78.24
2	3.07	31	58.35	60	46.55	89	68.88
3	-0.35	32	59.95	61	30.51	90	68.84
4	12.82	33	29.04	62	13.73	91	-3.71
5	46.94	34	-3.90	63	9.12	92	47.13
6	32.36	35	61.77	64	15.02	93	3.07
7	-37.03	36	60.81	65	36.43	94	75.11
8	7.41	37	51.54	66	52.37	95	53.35
9	46.29	38	40.63	67	36.49	96	64.47
10	24.62	39	50.70	68	39.75	97	65.18
11	38.04	40	58.39	69	19.97	98	81.12
12	30.44	41	-10.78	70	22.59	99	71.47
13	36.20	42	11.62	71	24.64	100	12.36
14	63.61	43	30.57	72	20.84		
15	21.84	44	38.47	73	40.23		
16	13.79	45	26.05	74	26.87		
17	59.08	46	46.66	75	26.08		
18	31.47	47	19.42	76	19.38		
19	43.33	48	26.02	77	72.59		
20	26.00	49	38.88	78	54.13		
21	5.53	50	27.02	79	73.50		
22	30.94	51	6.54	80	37.78		
23	16.51	52	38.41	81	59.49		
24	25.37	53	31.57	82	22.40		
25	37.93	54	21.31	83	24.53		
26	60.67	55	50.66	84	44.15		
27	5.46	56	53.93	85	33.71		
28	38.07	57	14.81	86	49.78		
29	25.13	58	10.91	87	64.08		

OCCUPATIONAL KNOWLEDGE TEST

VERSION 102G

INDEX OF DISCRIMINATION

1	52.04	30	25.09	59	34.49	88	2.50
2	32.63	31	9.52	60	45.18	89	36.99
3	49.48	32	57.14	61	28.11	90	52.32
4	27.99	33	56.56	62	54.58	91	29.45
5	13.82	34	51.56	63	56.97	92	61.27
6	66.26	35	27.81	64	16.67	93	66.20
7	61.56	36	25.55	65	59.52	94	-2.14
8	32.99	37	48.84	66	66.26	95	26.89
9	23.23	38	51.74	67	40.07	96	47.04
10	68.81	39	22.47	68	37.05	97	17.07
11	29.97	40	29.91	69	59.35	98	44.08
12	-11.79	41	30.95	70	19.97	99	37.05
13	-12.95	42	-6.97	71	47.32	100	83.04
14	68.93	43	39.95	72	-30.83		
15	-3.48	44	26.07	73	44.20		
16	42.16	45	27.41	74	46.64		
17	33.22	46	49.76	75	68.59		
18	7.14	47	20.73	76	45.12		
19	47.22	48	71.08	77	52.32		
20	61.79	49	21.31	78	59.29		
21	54.58	50	68.64	79	51.86		
22	7.78	51	49.42	80	61.09		
23	39.90	52	56.58	81	39.72		
24	19.05	53	32.05	82	22.88		
25	66.26	54	75.85	83	54.53		
26	32.00	55	37.34	84	27.75		
27	49.30	56	22.71	85	56.80		
28	-4.58	57	29.73	86	69.05		
29	42.86	58	78.28	87	56.80		

OKT 102H

OCCUPATIONAL KNOWLEDGE TEST

VERSION: 102H

INDEX OF DISCRIMINATION

1	42.39	30	21.52	59	6.82	88	47.89
2	55.19	31	57.72	60	57.39	89	67.87
3	24.13	32	51.92	61	41.32	90	45.93
4	40.52	33	34.02	62	38.41	91	51.16
5	61.87	34	48.07	63	44.75	92	34.90
6	58.96	35	8.86	64	24.83	93	62.33
7	3.00	36	16.58	65	27.90	94	63.36
8	37.31	37	68.94	66	75.25	95	33.10
9	56.16	38	30.66	67	54.64	96	10.34
10	50.36	39	11.19	68	36.45	97	73.04
11	36.73	40	36.70	69	32.61	98	-5.97
12	13.34	41	64.49	70	44.98	99	33.17
13	-11.66	42	51.69	71	77.98	100	14.33
14	17.51	43	43.48	72	57.55		
15	33.94	44	3.65	73	31.92		
16	25.13	45	66.47	74	20.86		
17	50.39	46	34.43	75	39.89		
18	27.87	47	9.23	76	23.81		
19	27.07	48	69.53	77	36.17		
20	32.09	49	42.09	78	40.77		
21	58.40	50	33.73	79	33.79		
22	68.46	51	49.99	80	34.43		
23	8.40	52	35.92	81	23.42		
24	30.22	53	14.71	82	22.70		
25	9.02	54	41.88	83	7.31		
26	46.62	55	58.14	84	62.15		
27	34.98	56	2.14	85	71.16		
28	20.25	57	29.26	86	53.08		
29	27.57	58	30.84	87	27.85		

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

prototype ATC test battery. The test protocol consisted of the Multiplex Controller Aptitude Test (MCAT), a job simulation test; and the Occupational Knowledge Test (OKT), a job knowledge specific test. FAA ATC Academy trainees during the period 1978-1980 that had taken both the MCAT and the OKT prototype tests provided 1,954 test subjects. Each subject was tested using two versions of the Multiplex Controller Aptitude Test (MCAT1 and MCAT2) and the Occupational Knowledge Test (OKT) providing 2,499 records for analysis. Regression analysis indicated that the predictive validity for successful completion of the FAA ATC curriculum of the MCAT1, MCAT2, and OKT, was significant at the $p < .001$; however, the R^2 was low ($R^2 = 0.122$). Consideration of causes for the low R^2 includes nonuniform distribution of subjects and possible preselection as the population sampled had previously passed FAA/ATC entry criteria. Item analyses indicated the MCAT contained very difficult or very easy questions in over 50 percent. The OKT had acceptable levels of item difficulty at the 25 percent level. Analyses of variance of the versions of each selection test (MCAT1, MCAT2 and OKT) indicated significant difference among the versions. The nonuniform-distribution of subjects and a learning effect between the test versions were considered as contributing to these differences. Subject sampling and design counterbalancing problems were discussed as possible contributing factors to the low overall R^2 . Recommendations are presented for further revision and analysis to improve the question utility and to develop a sequential test evaluation of the ATC applicant learning abilities.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)